STATUS AND OPPORTUNITIES OF PRIVATE FORESTRY

FROM

"A NATIONAL PLAN FOR AMERICAN FORESTRY"

A Report Prepared by the Forest Service, U. S. Department of Agriculture
in Response to S. Res. 175 (72d Congress)

SENATE DOCUMENT No. 12 – SEPARATE No. 10

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STATUS AND OPPORTUNITIES OF PRIVATE FORESTRY

By Burt P. Kirkland, Principal Forest Economist

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PRESENT CONDITION OF PRIVATE FOREST LANDS

Forest productivity is governed by natural forces in much greater degree than by man's efforts. The better a region's climatic and soil conditions are adapted to the forest as a vegetative type, the greater the region's forest productivity. It is for this reason that even in the regions of the United States where settlement took place earliest and where, consequently, the forests have undergone exploitation for the longest period, private forest lands still yield considerable volumes of forest products. Data readily available show, unfortunately, that neglect and actual abuse of the forest resource under private control have reduced the productivity of this resource to a small fraction of what it might be. From the standpoint of national supplies of forest products the economic results of this reduction are not yet fully apparent, owing to the continued availability of considerable volumes of virgin timber. Locally and regionally, however, adverse economic results are apparent on every hand.

PRESENT AND POTENTIAL EXTENT

Probably the most enlightening way to approach the problems of private forest ownership is to consider the actual productive status of privately owned forest land in comparison with its reasonable possibilities. As a basis for such consideration the total area of privately owned forest lands of different classes and in different regions is shown in table 1. Privately owned forest lands are shown to have a total extent of 396,239,000 acres, and to be widely distributed, the greater part of the total area occurring in the eastern and southern regions. Table 2, showing the character of the forest growth on these lands discloses a distribution of forest supplies that contrasts with the distribution of the land itself; for example, the Pacific coast region, which as table 1 shows contains only about 8.4 percent of the private forest area, has about 60 percent of the privately owned standing timber.

TABLE 1.—*Amount and character of privately owned commercial forest areas of the United States* [1]

Region	Aggregate			Saw-timber areas			Cordwood areas		
	Total	Farm woodland	Industrial	Total	Farm woodland	Industrial	Total	Farm woodland	Industrial
	Thousand acres	*Thousand acres*	*Thousand acres*	*Thousand acres*	*Thousand acres*	*Thousand acres*	*Thousand acres*	*Thousand acres*	*Thousand acres*
New England	25,978	6,402	19,576	13,261	2,427	10,834	4,541	1,700	2,841
Middle Atlantic	24,931	9,461	15,470	7,200	3,468	3,732	9,698	3,613	6,085
Lake	49,073	14,281	34,792	4,424	1,793	2,631	7,833	4,607	3,226
Central	63,477	32,158	31,319	20,921	12,158	8,763	25,368	12,432	12,936
South	187,264	57,866	129,398	55,220	13,729	41,491	52,013	19,789	32,224
Pacific Coast	33,037	5,099	27,938	18,907	1,740	17,167	3,098	928	2,170
North Rocky Mountain	7,338	1,413	5,925	3,554	364	3,190	1,025	309	716
South Rocky Mountain	5,141	43	5,098	2,778	34	2,744	1,686	3	1,683
Total	396,239	126,723	269,516	126,265	35,713	90,552	105,262	43,381	61,881

Region	Fair to satisfactory restocking areas			Poor to nonrestocking areas		
	Total	Farm woodland	Industrial	Total	Farm woodland	Industrial
	Thousand acres	*Thousand acres*	*Thousand acres*	*Thousand acres*	*Thousand acres*	*Thousand acres*
New England	5,851	1,572	4,279	2,325	703	1,622
Middle Atlantic	5,072	1,724	3,348	2,961	656	2,305
Lake	24,683	5,399	19,284	12,133	2,482	9,651
Central	12,078	5,193	6,885	5,110	2,375	2,735
South	36,802	12,084	24,718	43,229	12,264	30,965
Pacific Coast	4,324	1,119	3,205	6,708	1,312	5,396
North Rocky Mountains	1,540	407	1,133	1,219	333	886
South Rocky Mountains	16	5	11	661	1	660
Total	90,366	27,503	62,863	74,346	20,126	54,220

[1] From table 3 of section of this report entitled "Forest Land the Basic Resource".

In the section of this report entitled, "The Agricultural Land Available for Forestry," the Bureau of Agricultural Economics reports that in eastern forest regions there are now 50 million acres of nonforested farm land either abandoned or no longer required for agricultural use.

It also estimates that 30 million acres will be added to this area by 1950. In general, such of this land as is not selected for public forests will be available for private forestry. Planting will usually be necessary, but is entirely feasible where the area is merely part of a managed forest property or other enterprise yielding regular net income. This is specially true of farm enterprises.

PRODUCTION AND INVESTMENT CONDITIONS

Continuity of forest productivity depends on the economic factors common to all industry, viz, natural resources, labor (including management), and capital. Since natural resources that can be used to produce business profits have now in general been capitalized, the business enterpriser usually considers these in the category of capital.

TABLE 2.—*Amount of saw timber and cordwood on privately owned forest land in the United States*

Region	Saw timber [1]			Cordwood [2]		
	Total	Farm woodland	Industrial	Total	Farm woodland	Industrial
	Million feet board measure	*Million feet board measure*	*Million feet board measure*	*Thousand cords*	*Thousand cords*	*Thousand cords*
New England	55,393	7,972	47,421	53,450	19,605	33,845
Middle Atlantic	25,831	12,000	13,831	116,129	42,904	73,225
Lake	32,733	10,962	21,771	115,475	45,505	69,970
Central	34,066	17,453	16,613	155,242	61,310	93,932
South	195,117	48,267	146,850	423,613	171,947	251,666
Pacific Coast	593,902	25,206	568,696	37,011	9,429	27,582
North Rocky Mountain	41,731	1,508	40,223	19,050	6,025	13,025
South Rocky Mountain	9,516	64	9,452	6,749	17	6,732
Total	988,289	123,432	864,857	926,719	356,742	569,977

[1] From table 7 of section entitled "The Present and Potential Timber Resources" of this report.
[2] From table 9 of section entitled "The Present and Potential Timber Resources" of this report.

Using the term capital in this inclusive sense, it is readily possible to examine the situation of the privately owned forests from the standpoint of the presence or absence of the capital necessary to maintain a continuous output of forest products. Understanding of the situation is materially assisted by dividing the capital investment, thus interpreted, into its main elements and estimating what percentage of the whole is represented by each. The main elements of fixed capital investment are the soil, the forest improvements, and the forest growing stock or standing trees. The proportions of the capital investment which these elements represent differ to some extent in different regions of the United States; in any region, however, for a forest property maintained in good producing condition they will usually fall within the following limits:

Producing element:	*Percentage of capital investment*
Soil	0– 5
Forest improvements	5–15
Forest growing stock	80–95

The low percentage represented by the soil is in considerable degree due to neglect of the productivity of forest soils in the United States. In those European countries where intensive forestry is practiced

forest soils are valued as high as $75 per acre, independent of the growing stock they carry. In such cases they constitute a higher percentage of capital investment than indicated above in the continuous yield forest.

The forest owner who extracts the raw material himself needs a moderate amount of additional capital for equipment and operating purposes. This is mobile capital, not necessarily tied up to any one property, and need not enter into the present discussion. Where a forest property is very intensively developed the proportion of investment in forest improvements, consisting mainly of transportation facilities but including some buildings, may be greater than 15 percent.

Where the forest growing stock has been removed, forest improvements usually become valueless. The same is more or less true of the forest soil. Attention from the standpoint of remaining capital values in privately owned forests should be directed to the classes of forest land shown in table 1 under the following headings:

Poor to nonrestocking.—Table 1 shows 74,346,000 acres in this class of privately owned forest land.[1] From this the growing stock has been entirely removed. The prospect of future income is so long deferred that soil value, also, has largely disappeared. It is doubtful that this area as a whole has 1 percent of the capital values necessary for continuous forest productivity.

Fair to satisfactory restocking.—Table 1 shows 90,366,000 acres in this class. Utilization of the young trees present by chance in so far in the future that here, also, forest capital is virtually lacking. The soil and trees together make up perhaps 5 percent of the capital necessary for reasonably continuous productivity. Capital investment alone will not immediately restore them, since the time requirement is inescapable.

Cordwood areas.—Table 1 shows 105,262,000 acres in this class. Privately owned cordwood areas include chiefly areas that have been depleted of saw-timber sized trees. They bear considerable stands of young trees which, if protected and developed, will grow into valuable timber. It is improbable, however, that their present capital value exceeds 20 percent of what it would be if they were built up to fully stocked producing forests.

Saw-timber areas.—Table 1 shows 126,265,000 acres of saw timber in private ownership. Even in this class more than one half of the privately owned area is occupied by second-growth stands that have suffered seriously from fire, insects, disease, and general lack of care. In regions of low precipitation, on extensive saw-timber areas the rate of tree growth is too slow for profitable management unless other resources are present. If private enterprise is to continue to function in the field of forest ownership, organized management of the remaining privately owned saw-timber area is immediately essential. If depletion of the forest capital (chiefly growing stock) in these forests is at once positively discontinued the problem of restoring the growing stock and productivity of associated depleted areas will be vastly simplified. Very little outside capital will then need to be brought in.

Since current or at least little-deferred income is a necessity in virtually all private business, timber that can profitably be cut in

[1] This total does not include the abandoned nonforested farm land mentioned in a preceding paragraph as potential forest land.

regular annual or periodic allotments is indispensable to private forest enterprise. On by far the greater portion of our forest area saw-timber stands must serve as a nucleus to every forest property expected to yield continuous annual income. The exceptions occur where pulpwood and other products which can be taken from small timber have a high value. The income possibilities of well-stocked saw-timber stands, such as exist plentifully on the Pacific coast and in portions of the north Rocky Mountain region and the South, are ample to permit including in private forest properties made up principally of such stands considerable portions of cordwood, restocking, and even nonrestocking forest area.

Possibly as much as 275 million acres, of which 125 million is in farm woodlands, is still adapted to carrying on private forest business operations on a sound and permanent basis. Should the opportunities in the field of private forestry prove widely attractive as the fundamental principles of forest management become better understood, it is possible that private enterprise will extend further into areas where the growing stock must be reestablished.

The section of this report entitled, "Present and Potential Timber Resources," subsection "Timber Growth" gives (in table 17) the results of a Forest Service investigation of growth of the forests of the United States as a whole, the most careful that could be made with the time and resources available. This shows a current annual growth, on both public and private forests, of 8,912 million cubic feet feet of usable material, including the equivalent of 11,731 million board feet of material of saw-timber size. It is safe to say that present growth on private forests does not exceed one fourth of what it might be even under crude forestry.

EFFECT OF LIQUIDATION POLICY ON THE FOREST RESOURCE

The foregoing brief summary of conditions on the private forest lands of the United States shows the effects to date of the application of the policy of "laissez faire" to the American forest resource. According to prevailing economic theory, if each private enterpriser pursues his own best interests the result of the aggregate of these efforts will be for the public welfare. The history of forest exploitation in the United States to date creates doubt as to whether this theory has justified itself as applied to the handling of natural resources. There is doubt as to whether this economic procedure has even operated to the advantage of the average private forest owner. Each time a forest region has been cut out to the point that lumber must be imported the freight charges per thousand feet of imported lumber have been far greater than what it cost to produce a thousand feet of stumpage in the region, if a sufficient growing stock had been reserved from the virgin forest. The regional result, then, has always been higher lumber prices plus a loss of local industry. For the great majority of individual owners the result has been termination of the enterprise without conversion of any considerable portion of the forest resource value to permanent forms of private wealth. The capital has been consumed currently instead of continuing to support industry and provide human sustenance. As in most other industries, it has been found impossible to make money while wasting capital assets on a huge scale.

PRESENT EXTENT OF SUSTAINED-YIELD PRACTICE ON PRIVATE FOREST LANDS

The formation of constructive forest policies for the future requires information as to how the remaining forest stands are being handled. Liquidation can be discontinued only through giving forest lands such care as will enable them to produce growth approximately equal in volume and value to the annual cut.

CONDITIONS IN COMMERCIAL FORESTS

During the year 1930 the Society of American Foresters, assisted by the Forest Service and by State foresters and others, made a Nation-wide investigation of the present management of private forest-land holdings more than 1,000 acres in extent. The investigation naturally centered on saw-timber and cordwood areas where cutting operations are still possible. There are perhaps 125 million acres of these areas, the size of the individual area averaging 1,000 acres or more. The results of this survey are shown in the following tabulation. All totals must be considered separately, because they overlap.

1. Companies or individuals making conscious effort to grow timber commercially	288
Acres under industrial forestry management	20, 951, 635
2. Companies giving their lands good care without timber-growing purpose, whose chance to inaugurate forestry practice is still good	42
Acres represented by these 42 companies	2, 243, 500
3. Companies using careful cutting methods designed to promote natural regeneration	178
Acres represented by these 178 companies	10, 568, 076
4. Companies attempting to put their holdings on sustained-yield basis	40
Acres represented by these 40 companies	3, 496, 631
5. Companies providing effective fire control independently of public cooperation, in addition to other forestry activities	253
Acres represented by these 253 companies	16, 884, 897
6. Companies practicing close utilization in the woods	75
Acres represented by these 75 companies	5, 896, 736
7. Companies making growth studies	8
8. Companies employing foresters in timber-production activities	79
Foresters so employed	146
9. Companies using consulting foresters	77
10. Companies using regional association foresters' services	7
(There is a general tendency to use Federal and State advice, and a few companies cooperate with forest schools.)	
11. Companies planting beyond apparently experimental scale	76
Acres represented (approximately)	100, 000
12. Companies producing nursery stock for planting	14
Trees produced annually by these 14 companies	30, 000, 000
13. Companies spending money to control insects or diseases	60
14. Companies using improved practices in turpentine operations (estimated)	48
Acres represented (estimated)	1, 500, 000

During the present year data of similar nature have been procured by the Forest Service. No very material change has been noted in the extent of private forestry effort; in some regions, however, a tendency to abandon forestry practices is indicated. This tendency is rather more marked in the West than in the East. It was found impossible to segregate private owners' efforts in the field of forest fire protection from the efforts of public agencies cooperating with them. (Cooperative fire protection is discussed in other sections of

this report.) Data as to measures to prolong productivity, and as to organized sustained-yield practice, are given in the following tabulation (as of 1931):

Region	Measures to prolong productivity	Organized sustained-yield management
	Acres	*Acres*
Pacific coast	1,224,050	209,400
Rocky Mountain	890,334	
South	2,755,000	1,354,000
Central States	1,560,000	92,600
Lake States	100,000	
New England and Middle Atlantic States	9,080,300	648,592
Total	15,609,684	2,304,592

Both tabulations show that forestry effort other than fire protection has been extended to less than 21 million acres. This is about 7 percent of the private forest area outside of farm woodlands. Sustained-yield management has been applied to slightly more than 2,300,000 acres, which is less than 1 percent of the privately owned forest area. These percentages would be larger if they were computed on the basis of the area which still bears sufficient growing stock for private operation.

Apparently private forest owners have not yet given adequate consideration to the advanced stage of liquidation of the private forests and to the savings realizable through conserving productive capital values. Further details in regard to the present status of private forestry in each forest region will be given later in this section.

CONDITIONS IN FARM WOODLANDS

Detailed information is lacking on the condition of farm woodlands. Numerous reports from observers show conclusively that as a rule the woodlands are producing to only a small fraction of their capacity. In nearly all regions fires continue to limit productivity; in some, the chief source of injury is unrestricted grazing. In all regions the woodlands suffer from cutting of trees that have not yet grown to a size to produce high-value material.

Notwithstanding these defects in management, farm woodlands are producing a large annual volume of forest products and are among the principal sources of farm income. The following data from the United States census of 1930 (*1*)[2] show the character and value of forest products cut from farm woodlands in 1929. (The quantities and values refer to products cut and ready for use or for marketing as raw material.)

Product	Number of farms reporting	Quantity cut
Saw logs and veneer logs	178,539	[a] 5,042,926
Firewood	2,431,921	[b] 34,110,529
Pulpwood	43,824	[b] 1,485,759
Fence posts	566.233	[c] 98,664,249
Railroad ties	65,745	[c] 15,338,786
Poles and piling	21,802	[c] 3,298,415
Total value forest products from farms		$242,042,245

[a] Thousand board feet. [b] Cords. [c] Pieces.

[2] For list of list literature and authorities cited see page at the end of this section.

In general, the annual cut of material from farm woodlands represents a sustained yield. In some regions, however, it is in considerable part made up of virgin or second-growth timber not being replaced in full measure by growth. Farm woodlands should be developed to sustain a larger output and larger local manufacturing industries. It is obvious from the above statistics that the proportion of high-grade material cut is lower than it should be. Diversion of considerable productive effort from other crops to forest crops would aid in relieving agricultural crop surpluses. The regional conditions will be discussed later.

ADVERSE CONDITIONS AND PRACTICES ACCOMPANYING THE LIQUIDATION OF PRIVATE FOREST LAND INVESTMENTS

UNWISE LOCATION OF MANUFACTURING PLANTS AND CONSTRUCTION OF EXCESS PLANTS

Economical utilization of forest products demands carefully considered location of the major manufacturing plants at points where forest raw materials can be concentrated at low cost and the manufactured product economically distributed to market. It also demands that no more plants be built than are necessary to utilize the production. Sometimes, of course, there are reasons for building temporary plants and for building plants disproportionate to the continuous productivity of the forest. Gross overbuilding and consequent wastage of capital both in building and in subsequent competitive marketing have occurred in every forest region. Such losses have been accentuated in late years, owing to the ease with which modern industrial methods produce large output.

Accompanying these losses, the taxation problem usually becomes acute. Stimulated development entails the presence of more people and hence necessitates more schools, roads, and public services than will be needed permanently. This requires the levy of taxes beyond the amounts necessary under sound development. Moreover, as liquidation progresses the tax base becomes narrower, so that near the end of the liquidating period it is difficult to raise the revenues needed for the population which remains until plant operations cease.

Poor location of plants, lack of integration, and excessive number of plants requiring the same kind of raw material in one locality contribute to losses discussed in the following.

FAILURE TO COORDINATE DIFFERENT WOOD USES

Wood uses in the United States cover a wide range of products. Table 13 of the section of this report entitled "The Present and Potential Timber Resource" shows 20 major items of wood use requiring the cutting of 14,495,308,000 cubic feet of timber from our forests annually. Of this quantity slightly more than one half is cut for lumber purposes. As shown in the same table, additional uses requiring saw timber sized trees bring the cut of saw timber to about 70 percent of the average cut of the years 1925 to 1929.

Of the cordwood material used annually, 35 million cords are taken from trees under saw-timber size. There is no doubt that this cordwood could be supplied entirely from the remnants of saw-timber

trees and from thinning operations. Unfortunately, because of the somewhat localized use of fuel wood and the haphazard location of manufacturing plants which use such material, in many cases no market for material of this class exists within reach of the localities where the material is available. In many cases, however, coordination between saw timber and other uses is feasible but has not been effected, owing to indifference of forest owners, careless buying policies of manufacturers, and other causes. This has led and still is leading to the unnecessary sacrifice of young stands over large areas at the same time that prodigious waste is occurring in the utilization of saw-timber stands in the same localities. Millions of acres of young stands could be improved by thinning operations that would meet these cordwood requirements.

The outstanding example of woods waste resulting from lack of coordination of saw-timber with other operations is to be found in the Pacific Northwest. In an exhaustive study of logging waste in the Douglas fir region in 1926 and 1927 Hodgson (*2*) found that the waste averaged 42 cords per acre and totaled 6,448,000 cords annually. Virtually all this waste was of species suitable for one or another of the pulp processes. The volume of waste exceeded the entire quantity of pulpwood used in the United States. There is no immediate possibility of developing the pulp industry in that region to the point at which it could use all the waste. The waste could, however, be reduced by properly selecting trees for cutting, by adopting less destructive logging machinery, and by better balanced utilization. These measures are discussed later under the description of the Douglas fir region. Hodgson estimated that with a slight improvement in the economic conditions in the lumber industry at the time of his study, one third of the waste in the form of logs could be used for lumber.

OTHER FACTORS AFFECTING PRIVATE FORESTRY CONDITIONS AND POLICIES

DEMAND FOR FOREST PRODUCTS

The demand for forest products is treated fully in the section of this report entitled "Our National Timber Requirements." Here it suffices to point out that careful investigation of market requirements, while showing changes in the varieties of forest products marketed and shrinkage in the use of some forest products, indicates large continuing requirements. Landowners undertaking to manage forest land for continuous production are unquestionably entering a unique field of endeavor, in which the production of surpluses resulting from new growth is wholly improbable for at least a generation to come. Competition with timber properties that are being liquidated will apparently be the most serious limiting factor for the next few years.

Many communities in the forest regions of the eastern half of the United States are suffering from a lack of industrial balance resulting from decline in the forest resource. Where agriculture is the chief remaining resource, usually the local market for agricultural products has virtually disappeared and agricultural products must be marketed at a distance in direct competition with products from other agricultural areas. Restoration of forest productivity in these regions

would gradually restore the local market and the direct exchange of farm and forest products, and would make the community largely self-supporting from the standpoint of the great essentials of food and shelter. Data from many countries show conclusively that wherever these conditions of local production exist the per capita use of forest products far exceeds the per capita use in regions where these products have to be brought in from a distance at greatly increased costs.

STABILIZATION OF OWNERSHIP AND BLOCKING UP OF AREAS FOR PERMANENT MANAGEMENT

Institution of a private forestry enterprise requires a property the parts of which are at least adjacent and are so situated as a whole and with relation to each other that economical transportation facilities either exist or can be established, that existing markets can be economically reached or new markets created, and that all other factors of management can be properly coordinated. It is evident that the 127 million acres of farm woodland are already blocked up and represent ownership stability of the same order as exists for farms. The division of this section dealing with the extent of private forestry shows that possibly as much as 21 million acres of private commercial forest lands have been placed under some type of improved care in addition to fire protection. It is known that other commercial forest areas have been consolidated for exploitation purposes in a manner that would meet the requirements of permanent management. Enormous areas in unstable ownership remain to be redistributed among various forms of public and private ownership. The sooner this is done, with adequate precautions against mistakes, the more quickly the process of deterioration on these areas can be arrested.

ECONOMIC SIZE FOR FOREST PROPERTIES

Farm-woodland properties vary in size from 5 acres or less to 1,000 acres or more. The farm woodland is in a separate category in that it forms part of a unit managed chiefly for the production of crops other than forest crops. Certain industries other than agriculture, of which mining is a prominent example, may be linked in a similar manner with forestry operations on a small or large scale. Recreational use of land, particularly by country clubs or hunting clubs, is sometimes joined with forest production. Even for areas devoted more exclusively to timber production no general rule as to operating size can be laid down, because production of all types of forest raw material can be carried on either on one-man units of a few hundred acres or on very much larger units. Very seldom, however, will any economic advantage accrue from the assemblage of operating units of more than 100,000 acres. From the administrative standpoint it is extremely advantageous that the typical forest property remain of small size, subject to the detailed attention of the owner or operator; but this places the industry at some disadvantage from the standpoint of employing technical advisors and carrying on necessary research activities. For this reason it has proved necessary that research, and to a certain degree technical advice, be provided at Federal and State expense in the case of forestry as in that of agriculture.

ORGANIZING FOREST PROPERTIES

As in the case of any other property to be operated over a long period of time, carefully planned development and operation will add largely to the value of forest property and will increase the returns. Definite plans should therefore be made covering development and the main phases of operation for a period of five or ten years. These plans must consider engineering phases together with production and economic problems. Once the owner has decided to place the property under permanent management, it is natural that he will exercise more care in developing it. This does not always mean spending more money on transportation and like facilities than is spent on the exploitation forest; transportation facilities costing untold millions of dollars have had to be abandoned and written off the books as a result of the liquidation policy of cutting forests. It has been calculated that in a normal year as much as 1,400 miles of logging railroad, equivalent to half a transcontinental line, has been built in the Douglas fir region alone. Under an exploitation policy all this is abandoned and the investment written off in a few years. Under a continuous-production policy very few temporary facilities are built. Construction is not extended so rapidly, but the structures are permanent.

Since methods of handling forest stands for continuous production vary for different types, they will be discussed separately for each region, later in this section. The subject is raised here only to point out that all operations in the timber should be planned systematically for a reasonable period of years. The plans should provide both for obtaining current income from cuttings and for conserving permanent productivity.

Obviously, when such planning is to be performed, the measures prescribed must be attached to specific portions of the property. This necessitates mapping, and laying out permanent subdivisions with roads or topographic features as boundaries, so that extraction of forest raw materials can be carried on in the most economical manner when and where prescribed.

The planning just discussed will include budgeting the annual financial operations. The following headings suggest the main items usually included in such a budget:

A. Operating account:
   - Expense:
     1. Administration
     2. Taxation
     3. Protection
     4. Engineering and construction maintenance
     5. Insurance
     6. Capital charges (annual)
        - (*a*) Interest
        - (*b*) Depreciation
     7. Silvicultural costs
     8. Other costs
   - Income:
     1. From sale saw logs or timber
     2. From sale pulpwood
     3. From sale posts and poles, etc.
     4. From grazing
     5. From recreation, etc.

B. Capital account:
1. Road construction
2. Building construction
3. Other improvements
4. Purchase and sale of property
5. Etc.

Special attention is called to the fact that all items of expense except the silvicultural occur under any intelligent policy of responsible and permanent land management. Silvicultural expense is often a minor item and may not be present at all. As the operation becomes established it will usually be found profitable to set up at least a small budget item under that head. At this point it is desired to lay all possible emphasis on the fact that the outstanding financial and physical function of forestry is saving, not cost. Forestry saves productivity, saves forest land investments, saves forest improvement investments, prevents depletion, and saves all sorts of community investments dependent on continued productivity of the forest resource.

POTENTIAL PRODUCTIVITY

As in the case of agricultural production, rapid rates of growth and high yields are important favorable factors to be considered in carrying on forestry as a business. During the past few years studies of yield have been completed for many importantAmerican forest tree species, especially among the conifers. Species of rapid growth and high value are to be found in every important forest region.

Table 3, adapted from a table compiled by I. T. Haig (*3*), shows rates of growth and yield in terms of cubic feet and board feet for many different conifers of the United States. It should be noted that the average production over entire forest properties cannot be expected to amount to more than 60 to 75 percent of the growth rates shown in the table, which are those of fully stocked stands. Such species as redwood, sugar pine, and Douglas fir on the Pacific coast, white pines in Idaho and the Northeastern States, and loblolly, shortleaf, and slash pines in the Southern States, equal or exceed the growth rates of coniferous trees to be found anywhere else in the world. The same is true of our hardwood species as compared with hardwoods elsewhere in the north temperate zone.

The mere fact that a given species in an even-aged stand may grow rapidly from the time of origin of the stand to the time of harvest 60 or more years hence does not necessarily mean that the business of growing such stands from origin to maturity will yield a profit. Even if proved profitable in the long run it may not promote a business set-up that is within the field of private capital unless the forest property includes stands of many ages. For these reasons this discussion must be concerned chiefly with the current growth rates of trees approaching maturity in selection forests, or forests where a wide range of age classes are present in groups. Growth figures in connection with consideration of growing-stock conditions in various forest types will be presented under regional discussions.

TABLE 3.—*Rates of growth of 12 commercially important conifers*

Region	Species	Average site, or site index	Age on which site index was taken	Maximum average annual growth per acre		Age at which mean annual increment culminates		Yield per acre at 60 years		Reference
						Cubic volume	Bd. feet volume			
			Years	*Cubic feet*	*Board feet*	*Years*	*Years*	*Cubic feet*	*Board feet*	
South	Loblolly pine	90	50	131	750	35	50	6,700	43,000	(1)
Do	Longleaf pine	80	50	101	573	50	75	5,950	33,500	(1)
Do	Shortleaf pine	70	50	110	558	40	60	6,000	33,500	(1)
Do	Slash pine	80	50	143	567	15	45	5,750	32,000	(1)
New England	White pine	I	----------	136	828	45	60	7,980	49,700	(2)
Do	Red spruce	50	50	80	310	65	80	4,780	13,300	(3)
Lake States	Northern white pine	60	50	121	739	70	90	7,200	36,500	(4)
Do	Jack pine	Medium.	----------	79	214	35	70	3,750	11,500	(5)
North Rocky Mountain	Ponderosa pine	Medium.	----------	59	298	40	110	3,300	14,610	(6)
Do	Western white pine	60	50	118	760	100	120	5,880	23,250	(7)
Pacific Northwest	Douglas fir	160	100	170	1,190	70	80	10,200	66,200	(8)
California	do	100	50	180	962	50	70	10,500	56,900	(9)
Do	White fir	60	50	128	750	70	90	7,400	36,500	(10)
Do	Ponderosa pine	III	----------	66	350	120	130	----------	----------	(11)
Do	Redwood	II	----------	310	1,930	45	55	17,100	115,000	(12)

(1) U.S. Department of Agriculture Miscellaneous Publication 50; (2) Harvard Forest Bulletin 7; (3) U.S. Department of Agriculture technical bulletin 142; (4) University of Wisconsin Research Bulletin 98; (5) University of Wisconsin Research Bulletin 90; (6) University of Idaho, Forest Experiment Station Bulletin 1; (7) mimeograph report, U.S. Forest Service; (8) U.S. Department of Agriculture technical Bulletin 201; (9) University of California, College of Agriculture, Bulletin 491; (10) University of California, College of Agriculture, Bulletin 407; (11) Journal Agricultural Research 31, 1121–1135; (12) University of California, College of Agriculture Bulletin 361.

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ADJUSTING GROWING STOCK TO PRODUCE MAXIMUM RETURNS

It has already been pointed out that on forest properties expected to pay their way under private forest management the growing stock usually represents 80 to 95 percent of the total investment. Two factors dictate that a growing stock of varying ages be carried at all times: first, valuable merchantable material is produced only by many years' growth of a tree or stand; second, annual income can be obtained only by maintaining a succession of size classes, so that as the larger trees are cut others grow up to take their place.

CUTTING AND MANAGEMENT SYSTEMS

The many silvicultural systems recognized (*4*) form two major systems of handling cuttings in saw-timber forests as regards treatment of trees of different ages or sizes. The clear-cutting system (fig. 1) removes the complete stand at once over considerable areas,

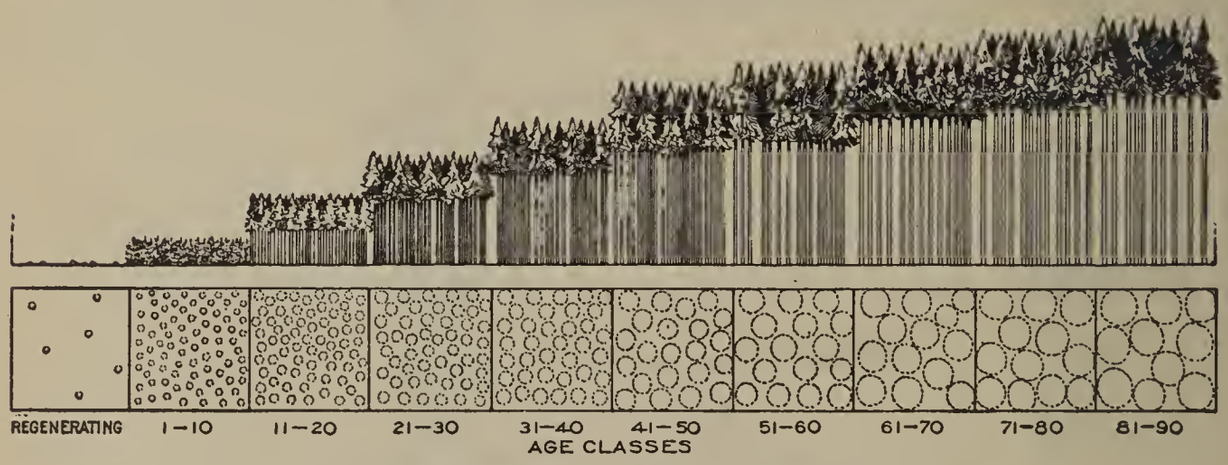

FIGURE 1.—Forest with series of even-aged stands.

with the result that if another stand follows it grows up even aged. The chief defects of this system are that natural regeneration often does not follow and that a large portion of the trees cut are removed at a loss when they might have been left to add valuable growth and reach maturity at an early date. The American forest regions in which this system has generally been followed have the most seriously depleted forests.

The selection or partial-cutting system (fig. 2) removes trees of merchantable size either individually or in groups with the minimum interference to the growing trees left. Young stock develops on the same ground occupied by the larger trees or in small openings, with little or no assistance or cost. The proper arrangement of cuttings among the larger trees aims to maintain on every division of the forest a growing stock of trees from 6 to 40 inches or more in diameter which are capable of earning currently through their continued growth the income necessary to pay all the operating costs and a net income besides. This income is not taken annually on every acre; the cut is rotated over the area once every 5 to 20 years. At each return to a given area 5 to 20 years' growth is harvested. The range of diameter classes in the stand varies with the species.

In considering the present condition of the growing stock in various forest types, its progressive modification in the course of cuttings to obtain current income, and the reservation of trees of proper sizes and characteristics to provide the best possible continued growth and

earnings, discussion is based on the assumption that this system of selection or partial cuttings will be followed in virtually all private forestry. It is recognized, however, that certain species such as Douglas fir, most of the pines, yellow poplar, white ash, and many oaks will not regenerate except in full or nearly full light. Therefore, the selection system as here contemplated includes "group selection" meaning that when regeneration of light-demanding species becomes necessary openings will be made in the stand, varying according to the species, the locality, the site, and the stand conditions from about one sixty-fourth of an acre to 5 acres in extent. In a few regions such as the Douglas fir region where regeneration comes easily and early growth is rapid, openings may occasionally be as large as 25 acres or in exceptional cases even larger. Data on growing-stock conditions in representative types and regions are presented with the understanding that the average acre given represents conditions in stands now on a selective basis or, where the stands are even aged, that the suggestions for treatment contemplate conversion to that

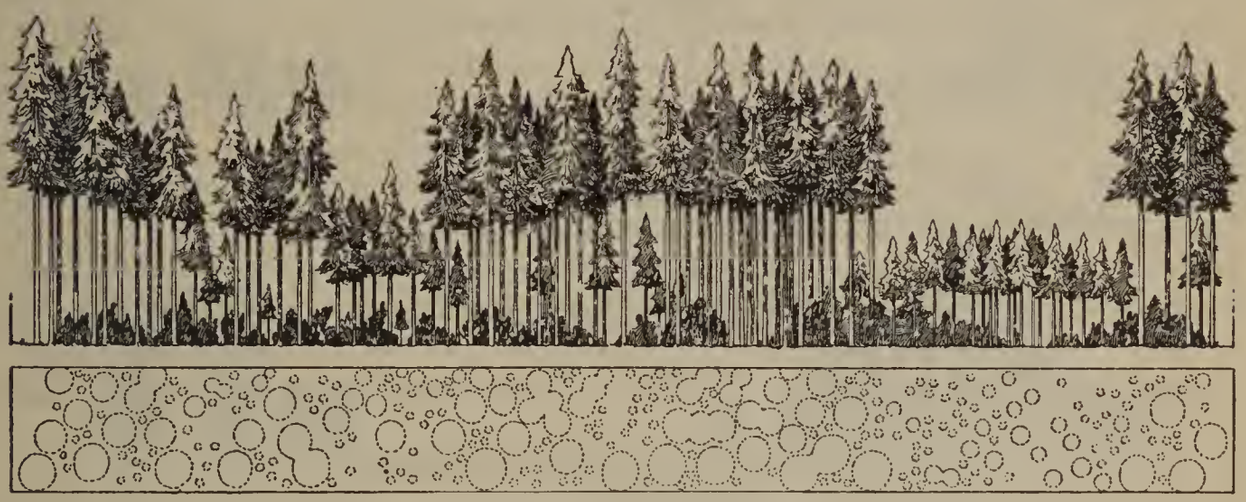

FIGURE 2.—Selection forest.

basis. The data and suggested treatment can be most readily visualized if thought of as applying to a forest area division of 25 to 200 acres, usually termed "compartment." The treatment recommended contemplates that every such compartment in a forest property shall at all times be stocked to the best advantage with trees of a certain diameter range, for most species from 6 to 40 inches or more, capable of laying on annual growth of high value.

The selection system has certain subsidiary advantages. It is safer from fire. Intensive research in various regions, notably the Northeastern, the North Rocky Mountain, and the Pacific coast, have proved that forest litter is inflammable a much larger portion of the time in the open than in the shade. In effect, in the forest the fire season is shorter. Also, larger trees are not so easily damaged by fire and can maintain a considerable rate of growth for the stand even if some smaller trees are occasionally killed by fire. Wind velocities are diminished by the larger trees, and fire is more easily controlled owing to this factor and to the fact that the low crowns of the young trees do not occur over large continuous areas.

Another advantage is that it is not necessary to cut trees of all sizes simultaneously; cuttings can be regulated according to market demands. The forest well organized on this basis is like a well-ordered warehouse in which the owner can take any goods he desires off the

shelves and thus meet varying demands for different classes of materials. At one time saw timber may be in heavy demand; at another, pulpwood from thinning the groups of smaller trees.

Since American examples of intensive forestry practice with adequate record keeping over long periods of time are lacking, the desirable growing-stock conditions in a forest developed according to the principles discussed above are best shown by citing a European example. The communal forest of Couvet in the Canton of Neuchatel, Switzerland, is appropriate owing to careful direction of its management for many years by the eminent Swiss forester Dr. H. C. Biolley and owing also to the careful, detailed records (*5*). This forest, under continuous-yield management for many years, has been subjected since 1890 to a careful procedure of building up the growing stock in order to improve the volume and quality of production. To a

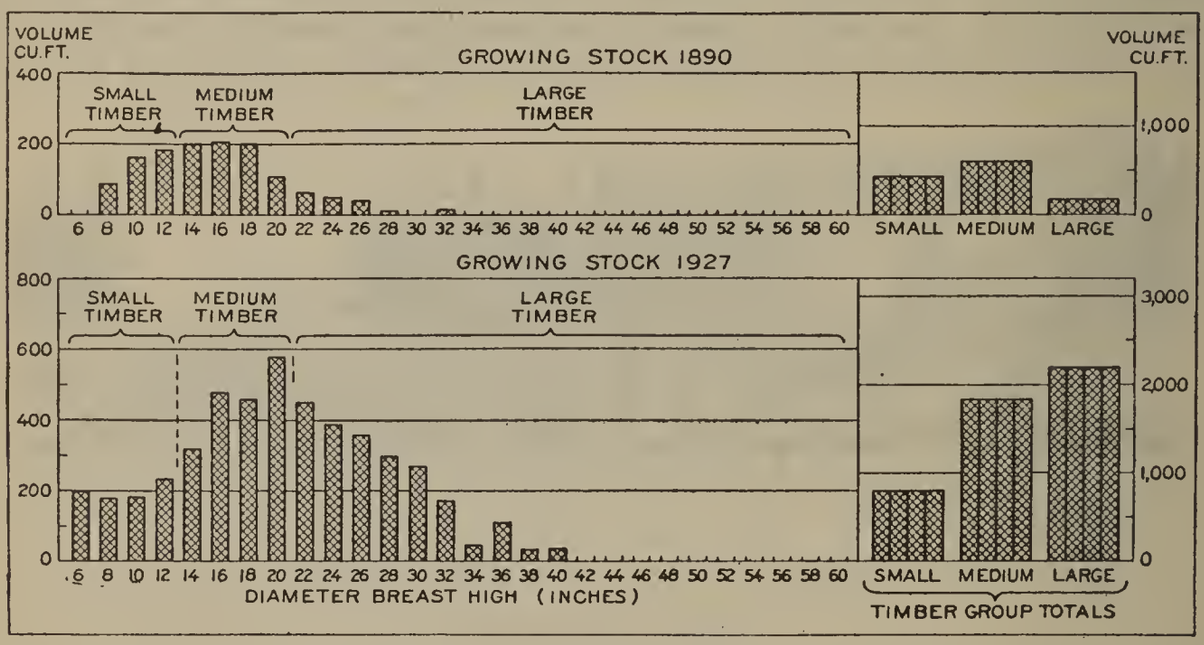

FIGURE 3.—Distribution of cubic volume by diameter classes on average acre, communal forest of Couvet, Switzerland.

remarkable degree, this has been accomplished without any impairment of the periodic cut at any time and with a material increase in the later periods.

Figure 3 shows graphically the condition of the stand in 1890 and its condition in 1927. The figures have been converted as accurately as possible from metrical units to English measurements and are in terms of the average acre in one division of the forest. The volume of the growing stock has been built up from about 1,246 cubic feet per acre to about 4,840 cubic feet per acre.

The annual cut per acre has been increased from 74 cubic feet to 128 cubic feet, and the average size of the trees cut more than doubled. The latter point is of extreme importance in increasing financial returns, owing to the higher unit value of large trees. The annual net returns did in fact increase during this period from $8.41 to $25.03 per acre. In America the closest resemblance to this Swiss example in species and growth conditions is to be found in the forests of the north Pacific coast, but a study of these diagrams will be instructive for forest managers in other regions as well. Some of our hardwood types can not be expected to bear any close resemblance to this example.

Within the past decade the application of production engineering technic to the study of logging and sawmilling practice has revealed that cutting operations in this country have been removing vast numbers of small trees, not alone to the severe impairment of the future productivity of the forest but also at a very heavy present loss. Table 4 shows results of such studies in six widely separated localities and in stands of different species. These studies were carried on entirely independently by different investigators, but all the results agree in principle. For each species cut for the general lumber industry there is a diameter limit below which cutting results in definite loss. Since stumpage is not charged as a cost in these studies, the data in the table mean that the trees below this diameter limit not only yielded no stumpage return from cutting but also caused a definite cash operating loss. All tree diameters above the upper heavy line drawn horizontally through the table are in this losing category. It is a mistake to cut trees even to this limit, for the reason that most of the sound growing trees capable of yielding only low returns from cutting now are more valuable for holding. It can be recommended then that as a general rule only trees of the sizes shown below the lower heavy line should be cut. The exceptions to this rule are trees of all sizes that are not of form and condition to grow further in value but on which something can be realized if they are cut at once. The trees of the sizes shown above the lower heavy line constitute the forest capital left after each cutting, which is responsible for the future earnings of the forest.

APPLICATION OF THE SELECTIVE CUTTING SYSTEM IN THE UNITED STATES

For more than a century European foresters have carried on cuttings on the principle of so selecting the trees to be cut that the residual stand will consist of trees capable of further growth in volume and value. In other words, they have managed cuttings in a manner to improve the stands. American foresters have advised a similar practice, but this procedure has seldom been followed on private lands in the United States.

TABLE 4.—*Net stumpage realization values per M feet board measure and per tree by diameter class, various species and regions, as determined by logging and milling studies* [1]

Diameter classes	Douglas fir [2] (Washington)		Sugar pine [3] (California)		Ponderosa pine [4] (Montana)		Shortleaf pine [5] (Arkansas)		Loblolly pine [6] (Virginia)		Red oak [7] (North Carolina)		Northern hardwoods [8] (Lake States)	
	Per M feet board measure	Per tree	Per M feet board measure	Per tree	Per M feet board measure	Per tree	Per M feet board measure	Per tree	Per M feet board measure	Per tree	Per M feet board measure	Per tree	Per M feet board measure	Per tree
8 inches							−$4.67	−$0.21	−$12.35	−$0.41				
10 inches							−.05	−.01	−5.60	−.33			−$2.93	−$0.18
12 inches					−$4.28	−$0.38	3.08	.35	.49	.05			1.00	.09
14 inches	−$18.45	−$1.84	−$21.15	−$2.12	−.46	−.06	5.59	1.06	5.23	.85	$4.75	$0.33	5.22	.68
16 inches	−13.94	−2.23	−13.51	−2.30	3.44	.65	7.59	2.08	8.31	1.99	7.60	.87	9.21	1.93
18 inches	−9.62	−2.31	−9.36	−2.15	6.19	1.55	9.36	3.64	10.80	3.42	10.10	1.72	12.87	3.47
20 inches	−5.48	−1.92	−6.52	−2.28	9.29	3.48	10.92	5.07	13.07	5.29	12.25	2.82	16.03	5.45
22 inches	−3.26	−1.66			12.19	6.03	12.26	8.43	15.19	8.05	14.24	4.27	18.95	7.96
24 inches	−1.17	−.76			14.08	9.22	13.54	10.38	16.83	11.51	16.04	6.10	21.59	11.23
26 inches	−.06	−.05			14.65	12.31	14.64	15.22	18.19	13.95	17.47	8.21		
28 inches	1.00	.93			14.55	15.28	15.69	20.21	19.05	16.25	19.01	10.84		
30 inches	2.19	2.36	3.33	4.66	14.38	19.12	16.73	25.70			20.55	14.28		
32 inches	5.06	6.48			14.37	24.43					21.92	18.52		
34 inches	5.55	8.16			14.55	29.83					23.20	23.66		
36 inches	5.67	11.06			15.56	36.88					24.33	29.44		
38 inches	6.09	14.25			18.31	48.16					25.27	36.05		
40 inches	6.10	17.45	10.84	33.60										
50 inches	7.15	31.89	17.87	99.89										
60 inches	8.85	60.18	24.57	226.04										
70 inches	8.84	83.18	27.44	335.86										
80 inches	9.38	113.97												

[1] By net realization value as shown in this table is meant the sum accruing to the timber operator, as stumpage, after deducting all operating costs from the market prices actually obtained for the product when sold. The percentages of each lumber grade produced from trees of each diameter class were determined in all studies. The current prices of each grade were applied to these percentages to determine the average price per M feet board measure by diameter classes. Logging and milling operating costs per M feet board measure for each diameter class were deducted from the lumber value to determine the net remaining. This is the realization value per M feet board measure. Realization value, per tree, for each diameter class is obtained by multiplying the value per M feet board measure by the number of M feet board measure, per tree in each diameter class. Further details of the methods of conducting these studies are to be found in any of the reports cited.

[2] Data from unpublished report on logging and milling studies in the Douglas fir region—Pacific Northwest Forest Experiment Station.

[3] See citation no. 6.

[4] See citation no. 7.

[5] See citation no. 8.

[6] See citation no. 9.

[7] See citation no. 10.

[8] See citation no. 11.

The movement of the value of the individual tree as the tree grows from one diameter class to another is due not only to the fact that the larger tree contains more wood but to the fact that the larger tree is more cheaply logged and milled, proportionately, and that its lumber is of higher average value. Under normal conditions the practice of holding sound, thrifty trees until they reach the stumpage realization values of from $5 to $10 per M board feet (shown below the lower heavy line in table 4) is likely to result in very satisfactory earnings. The probability of its doing so depends on the length of time it takes trees of a given diameter class to grow to the next higher diameter class.

Table 5 shows how gross compound interest earnings vary according to the number of years required to grow from one diameter class to the next higher, when realization values change as in the loblolly pine stands on which data in table 4 are based. The top line of compound interest earnings opposite 4 years shows the gross interest gained when any diameter class changes to the next higher, if the change takes place in four years. The rates earned if the change takes six years are shown on the second line, etc. The faster growing of the 12- to 18-inch loblolly pine trees grow 2 inches in 4 years in some localities and do so commonly in 6 to 8 years. The heavy line drawn downward through the table separates the diameters and growth rates which earn 6 percent or more gross compound interest from those that earn less than 6 percent. Taxes and other costs usually amount to from 1½ to 2½ percent of capital value, so that trees that earn 6 percent gross earn about 4 percent net. In general it is believed good business to hold trees as long as they earn 4 percent net. For loblolly and shortleaf pines this indicates a guiding diameter limit of about 17 or 18 inches. Well-formed, sound, rapid-growing trees above that limit continue to earn 4 percent or more net, while smaller trees of poor growth earn less than 4 percent net. Thus finance as well as silviculture indicates a flexible diameter limit to guide cutting. In regions of exceptionally rapid growth the lower limit of earnings that justify holding a tree may perhaps be set higher than 4 percent

TABLE 5.—*Gross earnings on timber investment due to tree growth*

Time required by tree to to grow from one diameter class into next higher	Diameter classes (inches)										
	8	10	12	14	16	18	20	22	24	26	28
	Average net realization value per tree in each diameter class (dollars)[1]										
	−0.41	−0.33	0.05	0.85	1.99	3.42	5.29	8.05	11.51	13.95	16.25
			Gross earnings when tree enters next higher diameter class (compound-interest percentage) [2]								
4 years	-------	-------	103.1	23.6	14.4	11.5	11.1	9.4	4.9	3.9	------
6 years	-------	-------	60.3	15.2	9.4	7.6	7.2	6.2	3.3	2.6	------
8 years	-------	-------	43.1	11.2	7.0	5.6	5.4	4.6	2.4	1.9	------
10 years	-------	-------	32.8	8.9	5.6	4.5	4.3	3.6	1.9	1.5	------
12 years	-------	-------	26.6	7.3	4.6	3.7	3.6	3.0	1.6	1.3	------
14 years	-------	-------	22.4	6.3	3.9	3.2	3.1	2.6	1.4	1.1	------
16 years	-------	-------	19.4	5.5	3.4	2.8	2.7	2.3	1.2	0.9	------
18 years	-------	-------	17.1	4.8	3.1	2.5	2.4	2.0	1.1	0.8	------
20 years	-------	-------	15.2	4.3	2.7	2.2	2.1	1.8	1.0	0.7	------

[1] Values are those given for loblolly pine in Virginia in table IV. They are based on a logging and milling study made in 1929 (*9*).

[2] Percentages shown in the 12-inch diameter column represent earnings due to growth from the 12-inch into the 14-inch diameter class. The percentages of course apply only to the trees that remain alive through the period required in each case to make the 2-inch increase in diameter. No deduction has been made for the expense of holding the trees during the respective periods. This item usually amounts to 1½ to 2½ percent of the capital value.

The sum of the values tied up in diameter classes at the left of and above the heavy line constitutes the investment in growing stock in terms of immediate realization value. All smaller tree sizes that show no immediate realization value can be valued, if at all, only by discounting the value they will have when merchantable.

The rate of earnings made by the trees in the residual stand is the principal guide in choosing trees for cutting. Where the forest is very deficient in growing stock it may be desirable to raise the guiding limit. If, on the other hand, there is a surplus-of growing stock, more small trees should be taken, to increase the growth and earnings of those left. At all times, trees of less than the chosen size but defective or indicated for removal to thin the stand should be taken if they can be marketed without loss. Selecting high-value saw timber and other valuable trees to produce the main income, and surplus, and ill-formed trees for cordwood uses, not only provides the forest owner with the maximum income from his property but also provides cordwood-using industries with cheaper products than can be produced independently of saw timber.

Conditions in typical stands in most of our important forest types are shown in 15 figures and 12 tables in conjunction with descriptive text distributed throughout the following regional discussions. In most of these figures heavy curved lines indicate the suggested limits of the permanent growing stock. It should be emphasized that while the suggested growing stock will without doubt provide for satisfactory rates of production in practically every case, these conclusions are only tentative. Careful investigation is needed to fix growing stock limits in any given case, and even then adjustments will constantly be necessary. These adjustments should be based on the fundamental principle of retaining a growing-stock investment sufficient to make the earnings of a forest property approximate the maximum possibilities. In the final analysis maintaining a sufficient growing stock is a matter of thrift—saving sufficient of the forest capital to provide for a high rate of continued forest productivity.

The reasons for the distribution of cubic volume among the different diameter classes and timber groups are as follows: The small timber (8- to 12-inch diameter classes) should be maintained only in sufficient numbers and volume to replace losses by mortality in all groups and recruit the medium timber as trees are removed from it by cutting or growth into the large timber group. The medium timber group (14- to 20-inch diameter classes), since it is generally the source of the highest investment earnings, should usually be maintained at a maximum of volume. Exceptions to this occur in the Pacific coast region where the production of large timber should be a constant aim. In other regions the proportion of the stand composed by the large timber group (22 inches diameter and over) may be expected to fall off rather rapidly with increase in size of the trees, because the trees have passed the point of large investment earnings. In these regions only a few exceptionally well-formed and vigorous trees should be held until they grow into the large-diameter classes.

REGIONAL CONDITIONS AND MANAGEMENT PRACTICES

PACIFIC COAST FORESTS

(Washington, Oregon, and California)

PRIVATELY OWNED TIMBER ACREAGES

Large-scale lumber production originated comparatively recently in the Pacific coast region. Cutting and other causes has already, however, removed the larger growing stock, suitable for continuous operation under a group or tree selective system, from one third of the privately owned area. Out of 33,037,000 acres privately owned, 6,708,000 acres are rated as nonrestocking and 4,324,000 acres as fairly well restocked with young growth. Farm woodlands include 5,099,000 acres; other areas in private ownership total 27,938,000 acres. The total regional privately owned stand is estimated at 594 billion board feet.

MANAGEMENT POLICIES

Until very recently, wherever the heavy stands of the Pacific coast region were operated, clear cutting was considered necessary, for mechanical and other reasons. (It was not considered necessary in the ponderosa pine stands.) Recent changes in logging machinery, including improvement of crawler tractors and development of associated log-tractor devices, make selective cuttings, either by single trees or by groups, entirely feasible. Selective cuttings are already freely practiced in some forest types, while in others only a beginning has been made. Most forest owners still hold to a policy of liquidating timber holdings. A few, realizing that present methods are undesirable, are considering or initiating changes in operating policy. Present management policies will be considered under three headings.

PROTECTION FROM FIRE

For most forest types in the Pacific coast region fire protection is recognized as prerequisite to sustained forest productivity. The standards of protection necessary under various conditions, and other aspects of the forest-fire problem, are discussed in detail in other sections of this report. Here it is sufficient to note that while some fire-protective effort is being made as a result of compulsory State patrol laws on virtually all the better-class timberlands, the burning rate has not been reduced to a low enough level to permit full productivity. Fire-protective efforts have made great progress and are unquestionably sufficient to permit a large volume of growth to take place, especially in the moist Douglas fir region.

MEASURES TO PROLONG PRODUCTIVITY

These include selective cuttings and intensive protection of young growth from logging damage. Nine Pacific coast concerns are practicing such measures on 1,224,050 acres. On considerable additional areas, without special intent on the part of the owners, conditions obtain that, as compared with the prevailing practices, will in some degree prolong the cut or productivity.

OPERATION ON A SUSTAINED-YIELD BASIS

Full utilization of productive values of the soil and full returns from investments in log-transportation systems, manufacturing plants,

dependent communities, etc., are possible only under a complete sustained-yield policy. Such a policy has been initiated by four Pacific coast operators owning about 209,400 acres of land and appears to be permanently established on these holdings. A number of the concerns mentioned in the previous paragraph have adopted management policies that could easily be altered to provide for sustained yield. In addition to this the redwood region, which with associated types comprises 1,400,000 acres, was formerly considered to be almost entirely on a sustained-yield basis. The redwood and associated forests are estimated to be capable of producing a sustained annual yield of one billion board feet. During the depression period, unfortunately, forestry practices have been discontinued on many redwood areas and even fire protection is now in a very unsatisfactory status. In this region the values that are subject to preservation through effective forestry measures are so large that resumption of these practices may reasonably be expected. Since virtually all the timber is in large ownerships, generally strongly financed, it is to be hoped that the owners will eventually adopt the policy that promises the greatest profits in the long run.

PRODUCTION AND CONSUMPTION OF FOREST MATERIALS

The annual lumber cut of the Pacific coast region is about one third of the national cut. There is little prospect in the near future of increased markets for the grades of lumber which make up the bulk of the present shipments out of the region. Especially as regards shipments to eastern markets for domestic consumption, other regions offer very keen competition in the lower grades. The competing eastern and southern forests, although now low in productivity per acre, are so vast in extent that they will inevitably continue to produce at lower cost to the consumer much of the forest material of ordinary grades required in the eastern United States. On the other hand the forests of the Pacific coast provide certain products, such as large timbers, wide clear boards, and veneers, that are hard to procure in quantity from any other coniferous forest region of the world. There are good possibilities of world-wide market extension for these products. If such extension is to be attempted it seems obvious that forest-management methods should be adapted to the continuous production of these classes of materials. Disastrous competition between the Pacific coast and eastern regions is likely to continue if excessive production of low-grade lumber is persisted in. The continued supply of high-quality products from the Pacific coast, however, will assist in effective utilization of local materials in eastern regions, through maintaining the position of wood as an acceptable building and industrial material. High-quality trees contain a large proportion of low-grade material, and the production of such trees is accompanied by the production of many small trees which will yield low grades if cut into lumber. West coast consumption can be counted on to absorb much of the lower-grade lumber produced in the region. Railroad ties and other products not of the highest value will continue to find a market in world trade. Table 6 shows the production and consumption of lumber for each State and for the region in 1928 (*12*).

TABLE 6.—*Production and consumption of lumber in the Pacific Coast Region in 1928*

[In thousand feet board measure]

	Production [1]			Total [2] consumption
	Softwood	Hardwood	Total	
California and Nevada	1, 952, 458	201	1, 952, 659	3, 158, 011
Oregon	4, 361, 904	10, 020	4, 371, 924	1, 044, 709
Washington	7, 291, 924	13, 353	7, 305, 277	1, 703, 867
Total	13, 606, 286	23, 574	13, 629, 860	5, 906, 587

[1] Data from Forest Products, 1928: Lumber, Lath and Shingles. Bureau of the Census, 1930.
[2] Figures based on compiled data in the files of the Forest Service.

The surplus in production over regional requirements in 1928 was 7,723,273 M board feet.

The exceptionally favorable location of many mills at ocean shipping points, and the high quality of the products, facilitate distribution to domestic markets and permit distribution throughout the world. The market possibilities shown by these statistics are slight in contrast with the huge volume of the timber in private ownership, if this is conceived of as available for immediate market. Every thousand feet of timber unprofitably marketed displaces a like quantity that ought to be marketed.

Pulp and paper products, veneers, creosoted piling, and other products are shipped out of the region in large quantities. A large volume of these and other forest products is consumed, also, within the region.

FINANCIAL ASPECTS OF PRIVATE FOREST OWNERSHIP

Col. W. B. Greeley, secretary-manager of the West Coast Lumberman's Association, estimates (*13*) that the 347 billion feet of timber in the Douglas fir region of Washington and Oregon has an investment value of $502,674,500. If the 247 billion board feet of privately owned timber in the pine and redwood types (including also all minor types) of the Pacific Coast States has similar average value, the investment value of all the privately owned timber in the three States approximates $860,000,000. Only in part does this represent actual investment. All the land passed from public into private ownership free or for a few cents per acre with the exception of that disposed of under the Timber and Stone Act, most of which was sold at the rate of $2.50 per acre. The transfer occurred principally during the last quarter of the nineteenth century, through railroad land grants, homesteading, and the Timber and Stone Act. The investment of actual money since acquisition consists in payment of local taxes and of fire-protection and administrative costs. If these costs have amounted to as much as 50 cents per M board feet, the actual money investment may still be less than $300,000,000. These costs have been met largely through proceeds from the sale of timber. The amounts that have been paid to local governments in taxes are in most cases many times the price originally paid to the Federal Government.

Many late comers in the region bought land from the original holders, and these have an actual money investment comparable to

the present capitalization rate of the whole. All this capitalization now enters into the balance sheets of individual and corporate owners, and cannot be eliminated or reduced except as a present loss. The maintenance of these values therefore represents a vital problem to thousands of individuals. Maintenance and even increase, if soundly based, is socially valuable, since where there is value care will be exercised. From the standpoint of the public and of the private owners, sound measures will be those that maintain values.

The policy of hasty liquidation of this investment has proved a costly failure, owing to the impossibility of placing this huge volume of timber on the market, in a short time, at a price that would recover all operating costs plus a sufficient depletion charge to return the investment. Large areas in the region are too inaccessible for profitable operation under any combination of price and operating-cost conditions that has yet occurred. Further than this, within the past few years studies of costs and returns from logging and milling operations, of the type described later in this chapter, have proved conclusively that in virtually every type of forest in the region cutting the small trees usually results only in loss. These studies have indicated that in accessible stands not more than 60 percent of the volume is suitable for cutting under cost and price conditions as of 1926 to 1929, and that in all probability less than 50 per cent of the total volume of all stands is operable under conditions of those relatively good years. If this estimate approximates the facts there remains 20 to 25 years' cut, under present economic conditions, of accessible financially mature timber. Under a selective cutting policy it may be necessary to slow down the cut to avoid overburdening the market with high-grade products.

The selective removal of this timber within that period would leave ample time for the remaining trees to grow into such sizes and values as to provide a like cut for the ensuing 20 years. This procedure would constitute a complete reversal of the policies in effect to the present date. It would make unnecessary the recovery, from operations of normal annual volume, of depletion charges which now amount to more than $30,000,000 annually (*12*a). Depletion would remain in some properties. In others, including areas cut over in the past but restocking with new growth and areas on which stands left after selective cuttings are developing, value increases would be accumulating. The history of forest values in other countries warrants the belief that this constructive policy might, if adopted, preserve unimpaired the larger part of the capital values of privately owned forests in the Pacific Coast States.

SAWMILL AND LOGGING INVESTMENTS

Colonel Greeley (*13*) estimates sawmill and logging investments in the Douglas fir region at about $300,000,000. If this ratio of timber investment to operating investments hold throughout the pine and redwood regions as well as the Douglas fir region, the whole investment must be in the neighborhood of $500,000,000. Here again the source of the original capital is of interest. Some of the capital was brought in from other regions. A considerable amount was raised by bonding timber tracts or by borrowing from banks. Past cutting of timber was the source of a large amount. This last is especially true of investment in logging railroads, which can often be paid for currently as they are gradually extended into the timber.

There can be little doubt that one half the existing facilities would supply all requirements of the market, provided a labor supply could be found for operating two or more shifts during the rare periods when lumber markets are very active. Again considerable numbers of low-grade logs are being transported long distances and cut in elaborate mills at high cost although they would yield just as valuable material if cut in low-cost local plants at a great saving of transportation and manufacturing expense and with a lesser capital investment. It is plain that large sums have been expended on manufacturing facilities in such a way as to compel unprofitable timber operations. Furthermore, there is grave danger that such expenditure has not come to an end. Not only have operating facilities been developed in excess of the need, but these facilities are poorly distributed with respect to the Pacific coast forests as a whole. In California and southwest Oregon large bodies of timber in private ownership are not served by any operating facilities.

The sums lost in overdevelopment of operating facilities would unquestionably have been ample to perfect fire protection and other measures of forest perpetuation, and thus to have placed the forests of the region on a sustained-yield basis. This would have meant permanence to the facilities developed, subject of course to ordinary wear and obsolescence.

PULP MILLS, VENEER PLANTS, ETC.

Large sums are invested in pulp and paper mills, veneer plants, etc., particularly in western Washington and in Oregon. Data on the amount of these investments are not at hand. Apparently there is little if any excess investment in these fields on the basis of normal conditions. The veneer plants are able to create from the highest grades of logs a product valued at as much as three times the value of the lumber that could be made from the same logs. Pulp mills usually operate 24 hours per day and make very intensive use of the capital investment. Plants of this type are able to create a high-value product from sawmill waste and from species which heretofore have been nearly worthless. Therefore they contribute to the earnings of the forest investment without increase in capital requirements and are a vital part in the economic welfare of the whole region.

A decrease in utilization of saw timber and a further increase in use of smaller-sized material are needed to eliminate the large waste still occurring. Selective cutting may bring about this balance without the necessity of further development of forms of utilization, providing definite coordination is established among the different forms of utilization.

AVERTING FURTHER OVERDEVELOPMENT OF MILL CAPACITY

Although manufacturing facilities are already overdeveloped there is grave danger that the first active lumber market will bring about establishment of mills to serve the nonoperated timber mentioned above. Two possible methods of deferring such development seem particularly feasible. The first and perhaps the simplest would be to return these areas to public ownership under conditions

that would protect the communities concerned. Payment in such case might be in special bonds bearing from 2 to 4 percent interest. A method of handling such purchases has been outlined by L. F. Kneipp (*14*).

The second method is to rely on private initiative to proceed on a basis of planned action that will take into full consideration the economic situation of the forest industries as a whole and of the West in particular. This would involve consolidating these areas into sustained-yield units of 20,000 to 100,000 acres each, well planned from the standpoint of topography and transportation outlets. These units, it must be recognized, would not be ready for immediate operation at their full capacity. They would be made up of cheap stumpage that should be held until market pressure is relieved by the discontinuance of numerous operations owing to exhaustion of their raw material. Future operating plans would contemplate a rate of cutting only equal to the sustained yield of the properites. Above all, the overdevelopment and consequent waste of capital which have characterized most of the localities opened up in the past should be avoided. Where possible, the safe and conservative business of forest ownership and management should be kept distinct from the entirely different and rather risky business of manufacturing and selling. The two lines require very different managerial abilities and have rarely been combined successfully.

These suggestions contemplate an ordered management, starting with virgin forest, in which capital is not wasted by overdevelopment of plant facilities nor productivity destroyed by removal of the growing stock. Under this policy it can be expected that in nearly every case some cutting will be necessary to meet local needs and that in a very few years demand will grow to larger proportions. Where income cannot be obtained immediately to meet current expenses it will be necessary to have access to financial reserves or credit facilities, as discussed elsewhere in this report.

MANAGING PACIFIC COAST TYPES TO MAINTAIN PRODUCTIVITY

DOUGLAS FIR FORESTS OF WESTERN OREGON AND WASHINGTON

The specific measures desirable in Douglas fir forests can be better understood by considering the distribution of size classes in typical stands. Figure 4 shows for an old-growth Douglas fir stand of meduim quality in Oregon the cubic volume, by diameter classes, on an average acre (*15*). The stand is about 80 percent Douglas fir, which includes the larger tree sizes, and 20 percent western hemlock.

Figure 4 also indicates approximately the quantity of timber of each diameter class that should be removed in the first cutting. The guiding diameter limit of 40 inches is based on the knowledge that from about 40 to 60 percent of the volume of the older virgin stands in the region is in diameter classes above that size; that these trees can be logged and manufactured the most cheaply; and that they will yield the highest-value lumber and therefore by far the highest net stumpage. They are the most subject to deterioration if not logged, and are in general decaying at a rate equal to or exceeding the gross volume growth of the stand. Some trees in thrifty condition over 40 inches may well be left standing, and trees under that limit but not of a

character to make net growth should be removed wherever that can be done at a moderate profit.

In these stands the larger trees are generally found in groups, and such selection will result in clear cutting on from 5 to 15 percent of the area in each cutting cycle. The resultant open spots will provide suitable conditions for regeneration of Douglas fir which, except in the fog belt and at high altitudes, is usually the most desired species. Complete slash disposal by the methods common in the region will usually be practiced on these spots. Either sufficient Douglas fir seed trees must be left to seed in an adequate proportion of fir on these spots or wide-spaced planting may be necessary as discussed under the spruce-hemlock type. The total number of trees removed will hardly exceed 6 to 8 per average acre. About 40 to 60 trees from 6 to

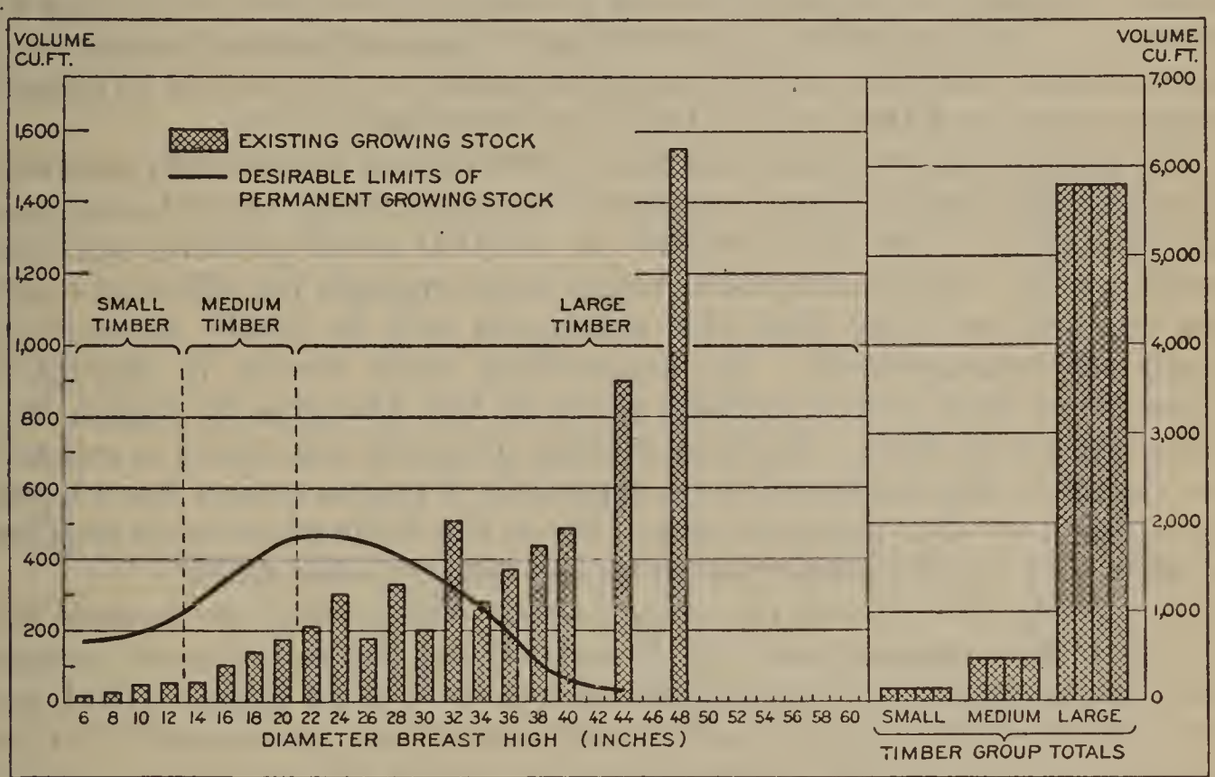

FIGURE 4.—Distribution of cubic volume by diameter classes on average acre, old growth Douglas fir with hemlock, western Oregon.

40 inches in diameter will remain; except for the open spots noted, the forest cover will be very slightly disturbed.

The residual stand will be in shape to accelerate its growth, especially in the lower diameter classes, which will be mainly hemlock. Although no precise data are available from such cuttings, it is known that hemlock accelerates its growth rapidly when released from crown and root competition. A net current annual growth of 400 to 800 board feet per acre can reasonably be counted on when the growth of the smaller tree classes increases. If the first cut passes over the whole forest property in 20 years, the second cut can begin immediately afterward in stands rebuilt to about 30,000 board feet per acre. The second cut should not greatly exceed the rate of growth during the cutting cycle, or about 10,000 feet per acre. The decision as to the quantity of timber to be removed in that cut should, however, be deferred until the time for the cut has come. It may then be desirable either to remove more of the growing stock or to rebuild it to some extent.

Under this procedure the returns from about 20,000 feet per acre of the first cut might be applied to the construction of permanent

improvements required by an operating forest property and to partial liquidation of the capital investment. At the end of the first 20 years' cutting period the liquidation phase would be practically completed and the remaining stand would constitute approximately the growing stock necessary for a continuously operated sustained-yield property producing at an average rate of 500 board feet or more per acre. Such a property will produce stumpage at a current cost for taxes, administration, and protection not far from $1 per M board feet.

The cost of production per 1,000 board feet in Douglas fir properties is, therefore, less than the accumulated investment per 1,000 board feet in many tracts of virgin stumpage, even exclusive of the values written into such stumpage. The cost differential against virgin stumpage as compared with currently produced stumpage will increase. The possibility of earnings on the investment depends, as in any other business, on the margin between the cost of producing the stumpage and the returns that can be realized on it.

The application of these methods presupposes organized operations on tracts sufficiently large to permit annual cutting operations on an efficient scale. Tracts of 20,000 to 100,000 acres present optimum conditions for such enterprises, being large enough for efficient operation but not so large that the managers will be likely to overlook details of management. In assembling such tracts it should be remembered that over 4 million acres in the Douglas fir region have been clear cut to date. Each operating property can carry a cut-over area equal to the timbered area, especially if regeneration has already taken place on the cut-over area. Even if a little planting is required the cost will not be burdensome to the project as a whole.

Frequently the growth of young stands will justify more rapid cutting of mature stands and will thus increase the current net returns from the property. A proportion of cut-over area such as that suggested represents a very small proportion of the investment. It can be relied on under good management to earn a low rate of compound interest in the form of an increase in capital value throughout the period of rebuilding the stands. Mixed stands of Douglas fir and hemlock coming up in the open spots left by early cuttings will at 30 to 40 years of age be ready for the first of the thinnings that will provide pulpwood, which is expected to be in permanent demand in the region. These stands as they approach maturity should be managed in a way to prolong the rotation, some of the trees being left to grow to large sizes. Early cuttings in these stands will produce as large quantities of poles, posts, tie timber, and similar materials as the market is likely to require. Later cuttings will yield high-grade saw timber. The presence of extensive young stands which even if conservatively managed will contribue a large quantity of low-grade material to the market, greatly facilitates maintenance of supplies of larger timber in the old stands suitable for the special market demands on the Pacific coast forests.

Although economic and other factors brought out in this discussion warrant placing great stress on selective-cutting practices, it is recognized that Douglas fir stands can be regenerated even if clear cutting is practiced on larger areas than suggested above. On a few tracts the timber is of such uniformly high value that selective cutting is not economically feasible. Certain topographic conditions, also, neces-

sitate clear cutting over considerable areas. Where larger continuous areas are cut within a short time fire protection is much more difficult. Fire once started is apt to sweep through the crowns of young stands at any ages under 30 or 40 years. Even surface fires are difficult to control on large areas of young stands. In the section of this report entited, "How to Stop Forest Devastation", methods followed in clear cutting on larger areas are described. The subject is discussed in detail also by Mr. Thornton T. Munger in a bulletin contributed from the Pacific Northwest Forest Experiment Station (*16*).

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TABLE 7.—*Number of trees, volume, and growth in a typical young Douglas fir stand about 110 years of age in western Washington*

Tree diameters at breast height	Trees per average acre				Time required to grow to next diameter class			Cubic volume			
	Douglas fir	Cedar	Hemlock	Total stand	Douglas fir	Cedar	Hemlock	Douglas fir	Cedar	Hemlock	Total
Small timber:	*Number*	*Number*	*Number*	*Number*	*Years*	*Years*	*Years*	*Cubic feet*	*Cubic feet*	*Cubic feet*	*Cubic feet*
6 inches	1.17	2.53	1.37	5.07	9	31	31	8.13	9.36	5.07	22.56
8 inches	1.23	1.77	1.10	4.10	6	27	27	16.36	13.88	8.62	38.86
10 inches	1.13	2.00	1.10	4.83	3	21	21	22.71	23.60	20.06	66.37
12 inches	1.90	1.93	2.07	5.90	35	16	16	53.77	38.60	41.40	133.77
Total	5.43	8.23	6.24	19.90				100.97	85.44	75.15	261.56
Medium timber:											
14 inches	1.70	1.93	.77	4.40	31	12	12	71.91	51.34	20.48	143.73
16 inches	1.87	1.30	.60	3.77	27	9	9	100.79	44.07	20.34	165.20
18 inches	2.20	1.10	.73	4.03	22	7	7	156.86	53.24	35.33	245.43
20 inches	2.77	.93	.70	4.40	18	6	6	255.12	60.91	45.85	361.88
Total	8.54	5.26	2.80	16.60				584.68	209.56	122.00	916.24
Large timber:											
22 inches	2.40	.57	.60	3.57	15	6	6	259.20	43.89	46.20	349.29
24 inches	2.70	.63	.46	3.79	13	6	6	332.10	56.07	40.94	429.11
26 inches	2.78	.90	.33	4.01	12	7	7	417.00	99.90	36.63	553.53
28 inches	3.20	.80	.20	4.20	10	9	9	579.20	108.00	27.00	714.20
30 inches	1.36	.50	.06	1.92	10	11	11	272.00	74.50	8.94	355.44
32 inches	1.50	.17	.10	1.77	9	14	14	361.50	29.75	17.50	408.75
34 inches	1.86	.17	.10	2.13	9	17	17	537.54	34.68	20.40	592.62
36 inches	1.56	.43	.07	2.06	10	21	21	522.60	102.77	16.73	642.10
38 inches	1.16	.13	.10	1.39	11	25	25	455.88	36.27	27.90	520.05
40 inches	1.03	.20	.03	1.26	12	29	29	433.63	59.60	8.94	502.17
42 inches	.60	.27	0	.87	12	34		268.80	92.61		361.41
44 inches	.37	.13	.03	.53	13	38	38	193.14	47.06	10.86	251.06
46 inches	.23	.13		.36	15	44		127.19	49.66		176.85
48 inches	.27	.17		.44	16	49		173.61	75.14		248.75
50 inches	.33	.10		.43	17	55		244.86	46.40		291.26
Total	21.35	5.30	2.08	28.73				5,178.25	956.30	262.04	6,396.59
Total for average acre	35.32	18.79	11.12	65.23				5,863.90	1,251.30	459.19	7,574.39

Tree diameters at breast height	Saw timber volume				Average annual growth of saw timber [1]			
	Douglas fir	Cedar	Hemlock	Total	Douglas fir	Cedar	Hemlock	Total
	Board feet	*Board feet*	*Board feet*	*Board feet*	*Board feet*	*Board feet*	*Board feet*	*Board feet*
Small timber:								
6 inches	30	20	30	80	3	5	3	11
8 inches	60	250	30	340	10	1	1	12
10 inches	110	320	70	500	22	2	1	25
12 inches	280	340	180	800	3	3	3	9
Total	480	930	310	1,720	38	11	8	57
Medium timber:								
14 inches	340	390	130	860	4	3	1	8
16 inches	510	290	160	960	8	9	4	21
18 inches	850	310	300	1,460	16	8	5	29
20 inches	1,510	310	380	2,200	27	24	18	69
Total	3,210	1,300	970	5,480	55	44	28	127
Large timber:								
22 inches	1,730	280	420	2,430	37	18	19	74
24 inches	2,570	430	420	3,420	61	21	15	97
26 inches	3,460	790	370	4,620	70	30	11	111
28 inches	4,950	890	270	6,110	96	20	5	121
30 inches	2,510	670	110	3,290	48	11	1	60
32 inches	3,300	270	190	3,760	62	4	2	68
34 inches	4,780	320	230	5,330	69	4	2	75
36 inches	4,530	960	180	5,670	62	8	1	71
38 inches	3,830	340	300	4,470	47	1	1	49
40 inches	3,860	570	120	4,550	43	2	1	46
42 inches	2,550	860	----------	3,410	20	4	----------	24
44 inches	1,720	480	150	2,350	17	1	----------	18
46 inches	1,210	530	----------	1,740	4	1	----------	5
48 inches	1,490	730	----------	2,220	7	2	----------	9
50 inches	2,660	480	----------	3,140	8	1	----------	9
Total	45,150	8,600	2,760	56,510	651	128	58	837
Total for average acre	48,840	10,830	4,040	63,710	744	183	94	1,021

[1] Data on rate of tree mortality were not taken. Net growth per acre may not exceed 75 percent of total growth shown.

In addition to the old-growth stands and the young stands that have developed following lumbering operations, there are in the Douglas fir region considerable stands of timber 40 to 150 years old which originated after fires. Stands that have reached an age of about 100 years can be cut in a manner similar to that recommended for old stands with about the same results except for two factors: The material removed will not yield much clear lumber, but will be uniformly sound, and will be excellent for structural timber; and, the residual stand will consist very largely of Douglas fir and will be in better condition to make rapid growth. Figure 5 and table 7 represent the conditions in a stand varying from 80 to 120 years of age (*17*). A few old veterans and a few groups of young trees are present in this stand, and cutting will be to a slightly lower diameter limit. About 30,000 board feet per acre will be removed and about 30,000 board feet left. Some groups will be cut clear to permit Douglas fir reproduction; the remaining stand will be managed for from 40 to 60 years longer, with cuttings about every 20 years.

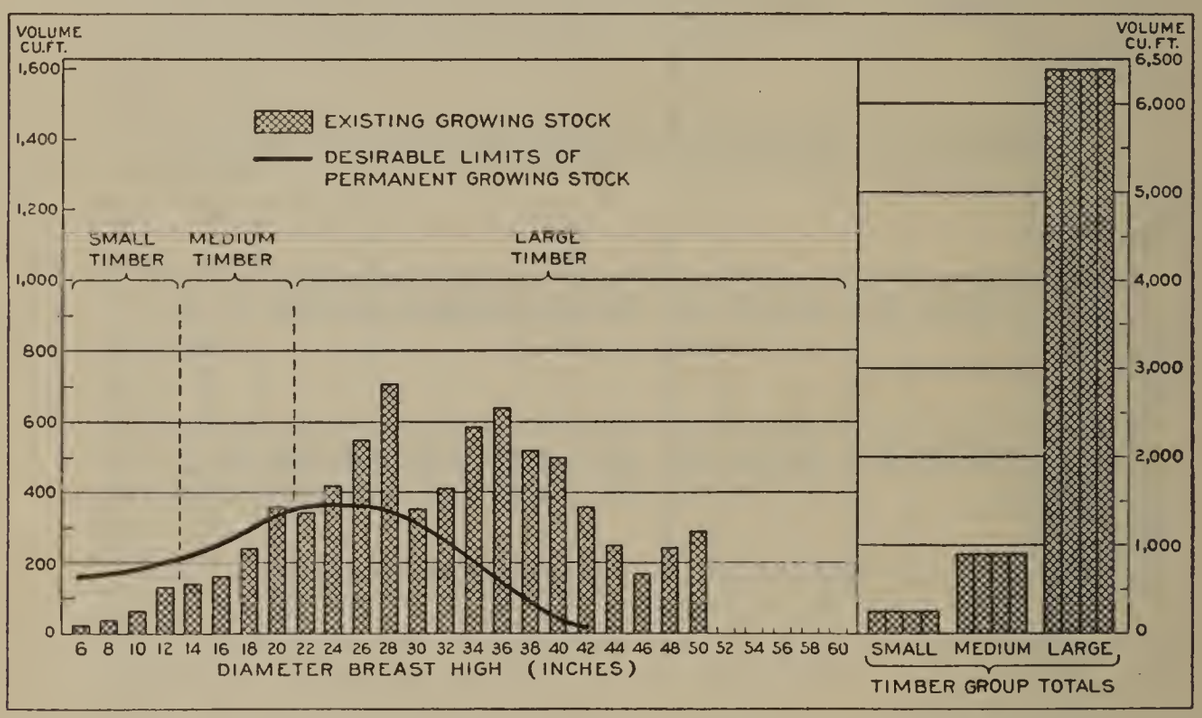

FIGURE 5.—Distribution of cubic volume by diameter classes on average acre, 80- to 120-year-old Douglas fir with a few old veterans (48- and 50-inch classes) and a subordinate stand of western hemlock and western red cedar.

Spruce-hemlock forests occur in a limited area known as the "fog belt" along the Oregon and Washington coasts. As Douglas fir, also, occurs to some extent in this belt, the area is considered part of the Douglas fir region. These particular forests present a remarkable example of two forest stands, of widely separated age classes, growing on the same area. The first constituent is the old spruce, ranging to 110 inches in diameter and probably 600 to 800 years old. This undoubtedly had a high percentage of even-aged hemlock associated with it at the start. As hemlock usually does not live to more than 300 years of age the hemlock stand has gradually changed to all-aged form, and now exists and develops almost independently of the presence of the few remaining spruce trees. The spruce stand includes most of the immediate realization values.

Figure 6 shows cubic-volume distribution by diameter classes on average acres for two closely adjacent areas in the lower Columbia

River region (*18*). On such areas it is recommended that the first cutting take the diameter classes to the right of the broken lines on the diagrams, which include all diameters above an average of about 44 inches. The reasons for this limit on cutting, brought out by an intensive investigation during 1932 of results of logging on these areas, are as follows:

1. If logging is confined to these limits the net stumpage realized in the Columbia River log market, even in the depression year of 1932,

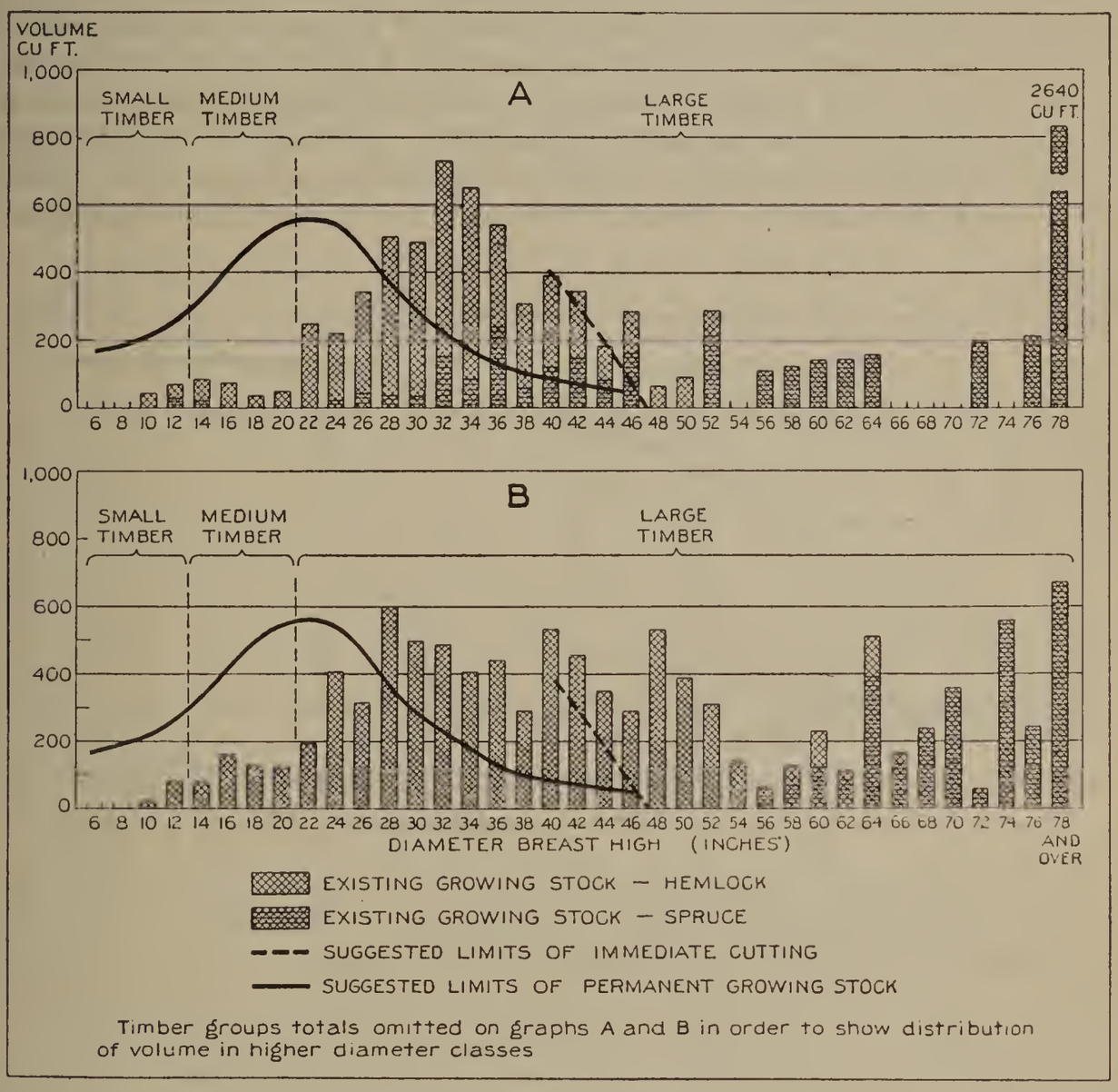

FIGURE 6.—Distribution of cubic volume by diameter classes on average acre in two typical spruce-hemlock stands, lower Columbia River region. A, Some spruce occurs in lower diameter classes: 5,550 cubic feet of spruce, 5,120 cubic feet of hemlock per acre; B, All spruce is 56 inches or more in diameter: 2,970 cubic feet of spruce, 7,820 cubic feet of hemlock per acre.

exceeds $6 per M board feet. The remaining diameter classes, consisting mostly of hemlock, will net considerably less than $2 per M board feet. Figure 7 shows the margin between log prices and logging costs for the spruce and hemlock, respectively.

2. In these old trees the otherwise merchantable portion of the bole already averages 35 percent defective. The trees are losing much more volume than the hemlock stand can grow; in fact, the growth of the hemlock is offset by the constant dropping out of hemlock trees reaching the age limit.

3. Cutting the spruce and some of the largest hemlock will give the smaller-sized hemlock a chance to develop. This will prepare the

way for the second cut, which will eliminate the remaining defective hemlock and leave a stand of adequate volume.

If only trees of the diameter classes to the right in the diagram for stand A are removed in the first cutting, as recommended, there will remain spruce seed trees to help seed the small areas cut clean in the first cutting. In stand B there is no spruce less than 56 inches in diameter and no seed will be available for the openings left by cutting. Wide-spaced planting (15 by 15 feet) with strong stock can be carried on at low cost and should assure spruce in the future stand. (Or fir and cedar can be used in the same manner.) The intervening space will fill with a dense stand of hemlock, which will insure natural pruning of the stand but will be sufficiently behind the spruce in development to permit survival of most of the latter. Hemlock reproduction will also come up abundantly within all small openings where single tree cuttings take place. Since hemlock is a valuable pulp species it

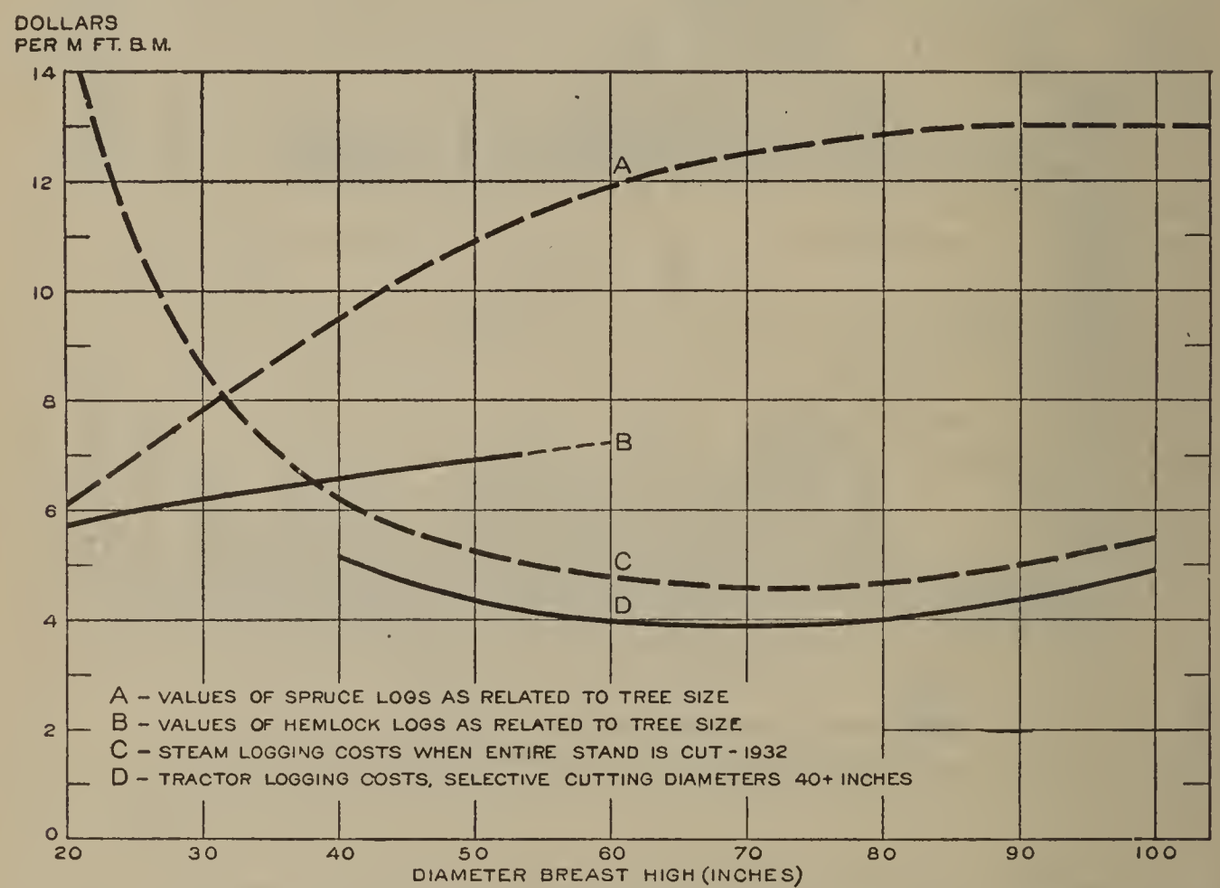

FIGURE 7.—Comparison of log prices (1932 log market) and logging costs, spruce and hemlock, Columbia River region, 1932.

can readily be removed in periodic thinnings from the time the young groups reach an age of 30 to 40 years. By these thinnings a constant increase can be brought about in the proportion of spruce in the stand.

In studies of the present year, two alternative methods have been worked out for logging an 80,000-acre tract in this type which bears about 3 billion feet of timber.

The first method assumes using the liquidation method ordinarily applied in the region and the ordinary machinery, cutting at the rate of 100 million board feet per year, and destroying everything as operations proceed. Under this method the Columbia River market (1932) value of the average log produced on this operation is $9.71 per M board feet. With logging costs deducted the net stumpage realization value is $3 per 1,000 board feet, giving a gross stumpage return of $300,000 per year.

Assuming a $3,000,000 debt against the tract, bearing 6 percent interest, will make it representative of the region. With the $300,000 a year applied to taxes (2 cents per M board feet on the timber standing, which equals $60,000 the first year and diminishes as timber is cut) and to interest ($180,000 the first year and diminishing as principal of debt is paid), and to principal ($60,000 the first year) it will take till 1956 to liquidate the debt. The income from a little more than 6 years' cut belongs to the operator. Discounted to present value at 6 percent interest, it yields an equity in the tract worth $454,130.

The second method involves liquidating high-value stumpage at the rate of 100 million board feet a year for 15 years. After that the cut is to be dropped to 50 million board feet a year on a sustained-yield basis. The average log value from trees over 40 inches such as will be cut the first 15 years is $11.34 per M board feet and the net stumpage realization, with tractor instead of steam logging, is $6.08 per M board feet (1932 depression prices and costs). For the first 15 years $608,000 a year is available to pay taxes and retire debt. After 15 years the income will be reduced both because of reduction in cut and because of lower value of material. Taxes are as under the other method except that they are cut down faster by removing high values, and the debt is entirely retired by 1938. The income from 1938 to 1962 belongs to the operator (except for tax deduction). Discounting these values at 6 percent to present value gives the result $2,821,924. In addition there will remain after 1962 a sustained-yield forest yielding 50,000,000 board feet per year.

It must be admitted that the tract on which these calculations are based is unusually well situated, close to deep water, but the principles involved apply in like manner to most of the remaining large tracts of virgin timber in the Douglas fir region. The returns will vary, but in virtually every case liquidation is the surest method devised for destroying values.

Although it seems self-evident that an operating method which in a few years destroys the current productivity of a tract capable, as in this case, of producing a sustained yield of 50,000,000 board feet per year must destroy large financial values, definite and reliable figures showing the real extent of such losses have hitherto been lacking. The figures presented here, since they are based on depression conditions, are undoubtedly ultra conservative both for liquidation values and for sustained-yield values.

COAST REDWOOD FORESTS

The coast redwood forests present problems similar to those of the Douglas fir forests. Lower-value species are associated with the redwood, so that the value of individual trees, varying both with size and with species, has a very wide range. These forests contain such a great proportion of large fine-quality trees that a selective logging practice partly on a group and partly on a single-tree basis is indicated which will permanently liquidate perhaps one half the capital value. The remaining growing stock would support at least the major portion of the investments in logging railroads, mills, and towns. Any complete liquidation policy would lead to proportionately greater capital losses in this region that in the Douglas fir region. No stand table is available for this type.

SUGAR PINE AND PONDEROSA PINE FORESTS (WITH OTHER CONIFERS)

The sugar pine and ponderosa pine forests (with other conifers in mixture) also present problems similar to those of the Douglas fir forests, except that logging operations are frequently more expensive and that the range of values is greater owing to the high values of high-grade sugar pine and ponderosa pine lumber. Logging practice has already been modified in some cases to provide for leaving a residual stand, but the present practice seriously decreases the percentage of pine in the stand and in some instances removes no white fir or incense cedar. Recent studies indicate that a much greater volume of pine should be left in the stand, for two reasons: First, the

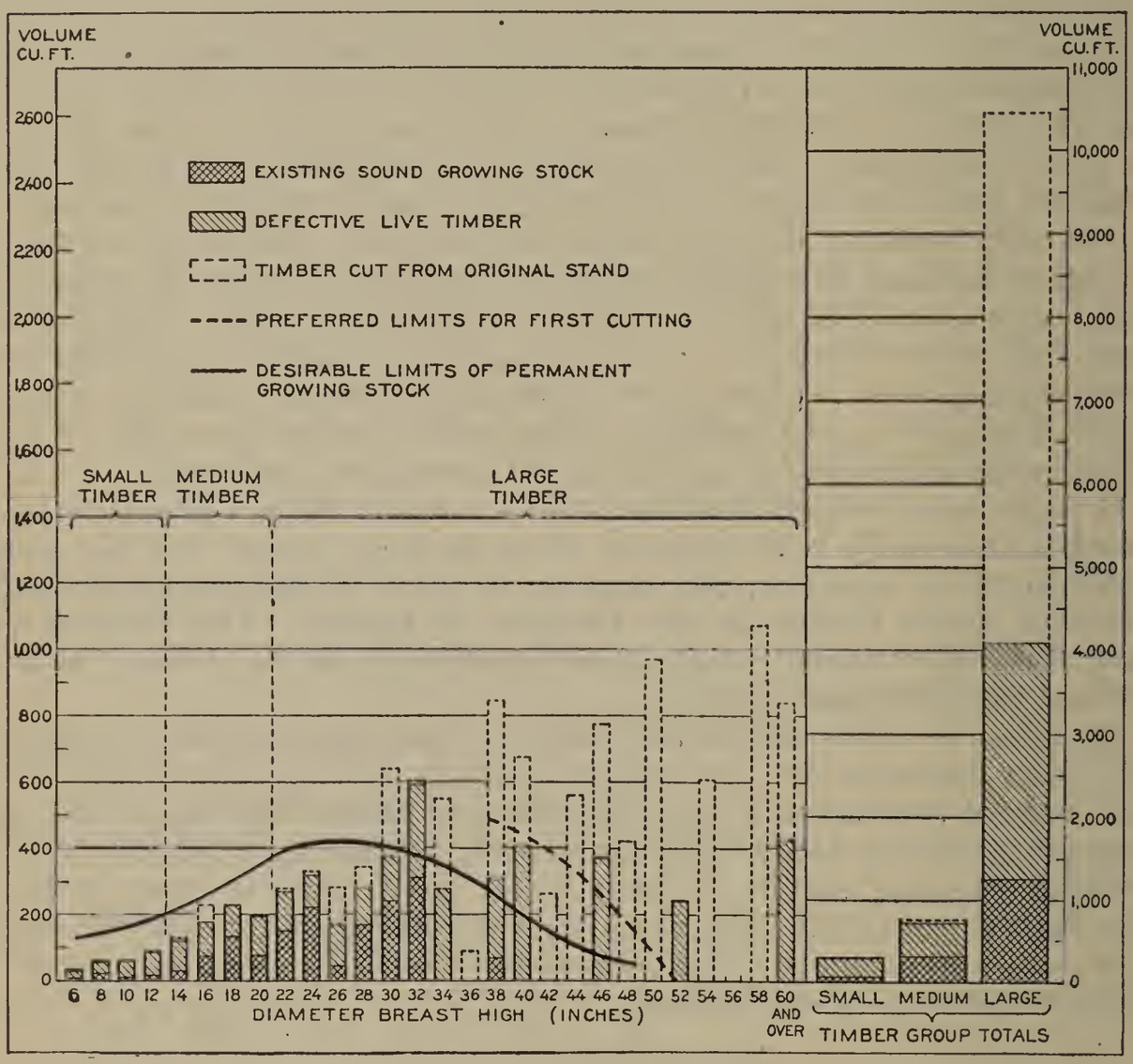

FIGURE 8.—Distribution of cubic volume by diameter classes on average acre before and after cutting in virgin stand of sugar pine and other conifers in California.

pine of smaller diameters is unprofitable to log; second, a larger growing stock will provide for greater production per acre. The guiding diameter limit indicated for selecting trees to be cut is from 36 to 44 inches.

Figure 8 and table 8 represent a typical stand on private lands as it existed before lumbering operations, and the sound and defective growing stock left after lumbering (*19*). The broken line shows the approximate point to which it seems the first cut should have been made, and the solid line shows an approximation to the stand that eventually might be accepted as satisfactory permanent growing stock. If the stand is cut in this way, a high stumpage rate will be realized on the current cut and the lower-value diameter classes will be preserved for further growth in volume, quality, and value.

TABLE 8.—*Number of trees, volume, and growth in a typical stand of sugar pine, with other conifers in California*

Tree diameters at breast height	Trees per average acre						Time required to grow to next diameter class					Cubic volume					
	Sugar pine	Ponderosa pine	Douglas fir	White fir	Incense cedar	Total stand	Sugar pine	Ponderosa pine	Douglas fir	White fir	Incense cedar	Sugar pine	Ponderosa pine	Douglas fir	White fir	Incense cedar	Total
	Number	*Number*	*Number*	*Number*	*Number*	*Number*	*Years*	*Years*	*Years*	*Years*	*Years*	*Cu. ft.*	*Cu. ft.*	*Cu. ft.*	*Cu. ft.*	*Cu. ft.*	*Cu. ft.*
Young stock: 4 inches	1.25		1.00	4.00		6.25	11		25	22		1.2		1.2	4.0		6.4
Total	1.25		1.00	4.00		6.25						1.2		1.2	4.0		6.4
Small timber:																	
6 inches	1.25	.50	.75	5.00	.75	8.25	8	10	18	13	14	4.3	0.8	2.3	15.0	1.7	24.1
8 inches	.75	.25	.50	5.25	.75	7.50	8	9	14	11	12	5.7	1.9	4.4	35.7	3.6	51.3
10 inches	.50			4.00	.75	5.25	7	8		10	12	8.0			51.2	7.0	66.2
12 inches	.50	.25		3.00	.75	4.50	6	8		9	11	5.8	6.2		65.1	11.8	88.9
Total	3.00	1.00	1.25	17.25	3.00	25.50						23.8	8.9	6.7	167.0	24.1	230.5
Medium timber:																	
14 inches				3.50	0.75	4.25		7		8	11				119.7	10.5	130.2
16 inches	.25			2.75	.50	3.50	6	7		8	11	11.8			139.7	20.1	171.6
18 inches	.50	.25		1.50	1.50	3.75	6	7		8	12	32.8	19.2		106.4	73.5	231.9
20 inches	.75			1.00	.50	2.25	5	8		9	12	65.8			94.9	31.3	192.0
Total	1.50	.25		8.75	3.25	13.75						110.4	19.2		460.7	135.4	725.7
Large timber:																	
22 inches	.25	.25	.25	.75	1.00	2.50	5	8	13	9	13	28.5	33.7	32.5	92.5	80.4	267.6
24 inches	.25			1.75	.25	2.25	5	8		11	13	36.5			269.9	24.9	331.3
26 inches	.25			1.25	.25	1.75	5	8		10	14	45.2			239.0	30.4	314.6
28 inches			.50	1.00		1.50		8	13	10				116.4	229.3		345.7
30 inches	1.25			1.00	.25	2.50	5	8		10	17	327.5			271.6	43.2	642.3
32 inches	.50			1.25	.25	2.00	6	8		10	17	151.2			398.3	50.6	600.1
34 inches	.25		.25	1.00		1.50	6	8	14	9		89.4		91.4	370.3		551.1
36 inches	.50					.50	6	8				104.0					104.0
38 inches		.50		1.00	.25	1.75		8		9	18		290.7		479.1	79.2	849.0
40 inches	.25			1.00		1.25	8	9		12		136.0			541.7		677.7
42 inches	.25				.25	.50	8	10			20	156.0				101.0	257.0
44 inches	.50	.25				.75	9	10				355.0	290.5				645.5
46 inches	.50			.50		1.00	10	11		14		400.0			375.6		775.6
48 inches	.25		.25			.50	11	12	18			222.1		204.2			426.3
50 inches	.75		.25			1.00	12	13	18			738.8		232.3			971.1
Total	5.75	1.00	1.50	10.50	2.50	21.25						2,790.2	614.9	676.8	3,267.3	409.7	7,758.9
Total for average acre	11.50	2.25	3.75	40.50	8.75	66.75						2,925.6	643.0	684.7	3,899.0	569.2	8,721.5

TABLE 8.—*Number of trees, volume, and growth in a typical stand of sugar pine, with other conifers in California*—Continued

Tree diameters at breast height	Saw timber volume						Average annual growth of saw timber [1]					
	Sugar pine	Ponderosa pine	Douglas fir	White fir	Incense cedar	Total	Sugar pine	Ponderosa pine	Douglas fir	White fir	Incense cedar	Total
	Bd. ft.	*Bd. ft.*	*Bd. ft.*	*Bd. ft.*	*Bd. ft.*	*Bd. ft.*	*Bd. ft.*	*Bd. ft.*	*Bd. ft.*	*Bd. ft.*	*Bd. ft.*	*Bd. ft.*
Small timber: 12 inches	34	32	----------	348	16	430	1	1	----------	5	1	8
Total	34	32	----------	348	16	430	1	1	----------	5	1	8
Medium timber:												
14 inches	----------	----------	----------	517	32	549	----------	----------	----------	35	3	38
16 inches	38	----------	----------	567	34	639	2	----------	----------	17	1	20
18 inches	112	70	----------	402	165	749	9	2	----------	21	8	40
20 inches	238	----------	----------	370	79	687	12	----------	----------	9	2	23
Total	388	70	----------	1,856	310	2,624	23	2	----------	82	14	121
Large timber:												
22 inches	105	137	132	508	216	1,098	10	6	2	17	10	45
24 inches	142	----------	----------	1,176	70	1,388	6	----------	----------	21	2	29
26 inches	193	----------	----------	1,110	90	1,393	7	----------	----------	19	2	28
28 inches	----------	----------	532	1,114	----------	1,646	----------	----------	5	31	----------	36
30 inches	2,321	----------	----------	1,376	146	3,843	80	----------	----------	32	3	115
32 inches	750	----------	----------	2,085	181	3,016	19	----------	----------	29	2	50
34 inches	449	----------	614	2,000	----------	3,063	11	----------	4	29	----------	44
36 inches	1,060	----------	----------	----------	----------	1,060	53	----------	----------	----------	----------	53
38 inches	----------	1,642	----------	2,680	308	4,630	----------	24	----------	41	3	68
40 inches	725	----------	----------	3,068	----------	3,793	29	----------	----------	77	----------	106
42 inches	854	----------	----------	----------	409	1,263	31	----------	----------	----------	7	38
44 inches	1,975	1,226	----------	----------	----------	3,201	29	13	----------	----------	----------	42
46 inches	2,278	----------	----------	2,204	----------	4,482	28	----------	----------	20	----------	48
48 inches	1,301	----------	1,252	----------	----------	2,553	27	----------	4	----------	----------	31
50 inches	4,395	----------	1,608	----------	----------	6,003	362	----------	5	----------	----------	367
Total	16,548	3,005	4,138	17,321	1,420	42,432	692	43	20	316	29	1,100
Total for average acre	16,970	3,107	4,138	19,525	1,746	45,486	716	46	20	403	44	1,229

[1] Losses from tree mortality and by wood-rotting fungi may entirely offset the gross rate of growth shown. This growth data is of interest to show the growth possibilities of this type under management which gradually eliminates the defective and over-mature trees from the stand.

Handling the white fir in these stands is a difficult problem. Undoubtedly this cutting method will leave more white fir on the ground than the silviculturist would advise. It is worth bearing in mind that the operating methods here contemplated involve construction of a minimum of railroad line, of which as much as possible will be permanent. The tractor roads over which the first cut is skidded out will be usable at any later time. It is suggested that under these conditions, when an active market occasionally occurs the operator can readily go back and at very low cost remove more of the white fir. Where this measure does not sufficiently favor the pine, removal of the

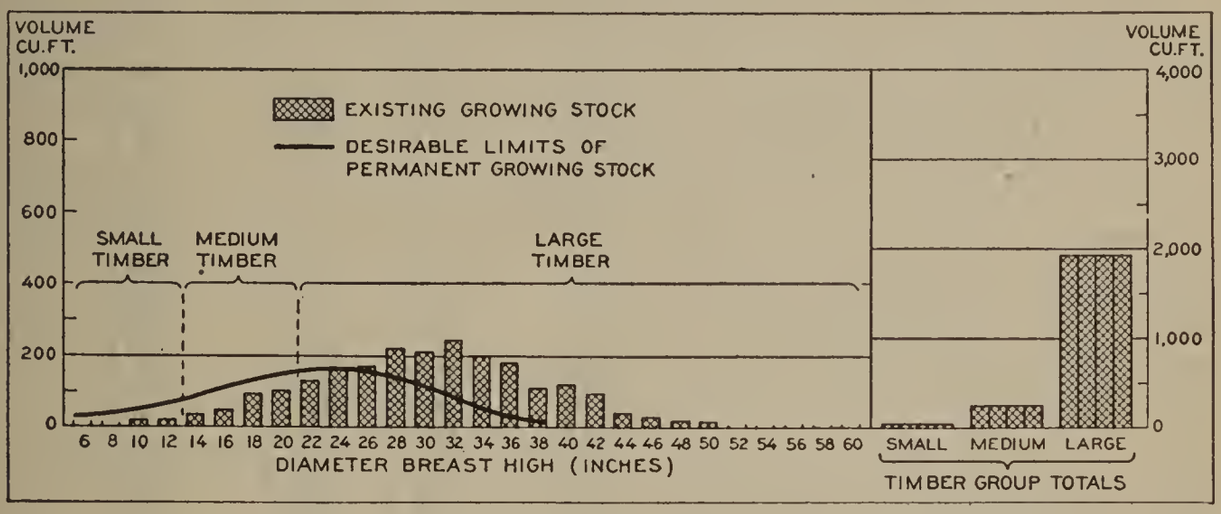

FIGURE 9.—Distribution of cubic volume by diameter classes on average acre, virgin stand of Ponderosa pine in eastern Oregon.

fir has to be accomplished by logging sizes below the profitable cutting limit.

PONDEROSA PINE FORESTS IN OREGON, EAST OF CASCADE MOUNTAINS

The ponderosa pine type of eastern Oregon, extending northward into Washington and southward into California, exists in a region of lighter rainfall than the types just described. The stands are therefore lighter and the growth much slower than in the stands shown in figures 4 to 8. As in those forests, cutting has usually been too heavy. Figure 9 and table 9 show the distribution of diameter classes and volume in a typical stand. Management problems in forests of this type are somewhat different from those in the Pacific coast localities of adequate rainfall. The growth is slow, and some observers believe it may prove necessary eventually to carry in public ownership much of the forest area in this type on which combinations of forest production with grazing or other land uses are not worked out. The measure immediately needed is to discontinue the cutting of small, unprofitable trees and through saving these for further growth to prolong the cut and hence the utility of the dependent mills.

TABLE 9.—*Number of trees, volume and growth in average stocked virgin stand of ponderosa pine in eastern Oregon*

Tree diameters at breast height (inches)	Trees per average acre	Time required to grow to next diameter class	Cubic volume	Saw timber volume	Average annual growth of saw timber [1]
Small timber:	*Number*	*Years*	*Cubic feet*	*Board feet*	*Board feet*
10	2.39	28	21.6	95	----
12	1.91	28	21.4	94	1
Total	4.30	----	43.0	189	1
Medium timber:					
14	2.01	25	40.0	176	2
16	1.62	25	52.0	232	3
18	1.88	25	96.0	423	1
20	1.47	25	104.0	465	5
Total	6.98	----	292.0	1,296	11
Large timber:					
22	1.64	25	131.6	735	3
24	1.53	33	168.4	940	5
26	1.20	40	172.9	965	3
28	1.23	33	220.3	1,230	4
30	.92	40	212.3	1,185	8
32	.90	50	248.1	1,385	4
34	.59	50	197.0	1,100	4
36	.48	50	184.5	1,030	4
38	.37	50	118.2	660	5
40	.34	50	121.8	680	5
42	.23	50	94.0	525	8
44	.06	50	39.3	220	6
46	.05	50	25.0	140	6
48	.02	50	21.1	118	6
50	.02	50	15.5	87	7
Total	9.58	----	1,970.0	11,000	78
Total for average acre	20.86	----	2,305.0	12,485	90

[1] No deduction has been made for tree mortality or losses from wood rotting fungi, etc. Net growth per acre may be as great as 85 percent of amount shown or insect and other losses may entirely wipe out the current growth in mature stands.

Studies of the growth of ponderosa pine by Dr. Walter N. Meyer, of the Pacific Northwest Forest Experiment Station (*20*), have shown that where sufficient growing stock is preserved after each cut the rate of growth is fairly satisfactory. Where a stocking of 2,000 cubic feet per acre is preserved 690 cubic feet is added to the volume in the next 30 years. Where a growing stock of only 200 cubic feet is preserved only 220 cubic feet of growth is obtained in that period. These results are from all-aged stands.

In terms of saw timber 11.6 inches or more in diameter, a stocking of 10,000 board feet produces 4,000 board feet of added growth in 30 years, whereas a stocking of 1,000 board feet produces only 1,300 board feet in the same time. Owing to greater risk of insect attack on older trees it may be undesirable to leave fully stocked stands after the first cutting in virgin timber. If understocked stands are left the growing stock should be built up with younger trees during further management operations.

It should be noted that while Meyer shows only 15 board feet per year mortality loss in selectively cut stands, he cites Bureau of Entomology studies made under the direction of F. P. Keen in virgin stands in southern Oregon and northern California showing insect losses amounting to from 103 to 1,082 board feet per acre per year in 1927, the year of heaviest recorded loss. On the 17,400 acres covered

by these studies the loss averaged 417 board feet per acre. By 1930 this had shrunk to 226 board feet per acre. It is possible, but has not been definitely determined, that insect injury would be reduced by passing over all the stands as rapidly as possible with a light cutting in order to eliminate the most susceptible trees.

FUTURE OWNERSHIP DISTRIBUTION OF THE PACIFIC COAST FORESTS

Competent local observers believe private ownership of forests on the Pacific coast will shrink within the next generation to 8 million acres, or less than one fourth the present figure. This appears to be a matter on which a dependable prediction cannot be made. If there is not a sufficient body of enterprisers to take advantage of the opportunities for operating these highly productive forests continuously, in the course of time the areas will automatically revert to some type of public ownership. This will take place through the tax-delinquency route if not otherwise. It is intolerable that these last magnificient forest areas should become waste lands stripped of their stands and degraded by ruthless cutting and fire. This would be too great a price for the preservation of individual initiative. It would in fact constitute the irrevocable extinction of individual initiative as applying to this resource.

On the other hand it has been abundantly proved that public ownership is capable of permanently preserving the productivity of these forests. If private ownership cannot preserve their productivity, it is possible to perpetuate the opportunity for individual initiative in the manifold activities connected with harvesting forest raw materials on public lands and with the diversified manufacturing enterprises using such materials.

In order to bring to an end the numerous losses incident to the logging methods of the past 20 years these practices should be stopped forthwith, by whatever means necessary. Various methods of stopping them are discussed elsewhere in this report. Private, State, and Federal agencies concerned should then enter into a thoroughgoing cooperative study of the whole region, unit by unit. The study should lead to conclusions as to which of the several agencies, private, State, and Federal, should handle each productive unit. No agency should undertake to handle any unit unless it is prepared to keep the unit in permanent producing condition and thus can accept the full responsibility that from now on should be irrevocably associated with the privilege of ownership of our remaining natural resources.

FORESTS OF THE ROCKY MOUNTAIN REGION

(Idaho, Montana, Wyoming, South Dakota, Nevada, New Mexico, Utah, Colorado, and Arizona)

STATUS AND MANAGEMENT OF PRIVATE FORESTS

The privately owned forest area in the Rocky Mountain region is estimated at 12,479,000 acres, of which 1,880,000 is poor to nonrestocking, 1,556,000 fair to satisfactory restocking, 2,711,000 cordwood, and 6,332,000 saw timber. (See table 1.) Roughly, one half the privately owned forest land is occupied by saw timber and bears an estimated stand of approximately 51 billion board feet. Farm woodlands total 1,456,000 acres. Of the remaining 11,023,000 acres

in private ownership a large part, undoubtedly, is held for other purposes than utilization of the commercial timber. This is an important grazing region, and most of the forest types yield considerable crops of forage.

The Rocky Mountain region as a whole has an interior continental climate with low precipitation. For this reason the forest growth is too slow, in the opinion of many authorities, to make permanent management attractive to private owners. This depends to a considerable extent on how successfully private owners coordinate the use of range and other resources. In a few localities, such as northern Idaho and portions of western Montana, topographic conditions cause precipitation adequate for rapid forest growth. Unfortunately the very valuable western white pine, which is the chief source of value in this section of adequate rainfall is threatened by the white pine blister rust. It is estimated that an immediate investment of about $2.50 per acre is necessary to protect the pine from injury from this source. Many private owners are unable to make this expenditure. Fire protection, also, is a source of heavy expense. If these expenses can be met permanent private management for commercial forest production is feasible in these localities. The returns forest owners will realize from these and other areas can in most cases be greatly increased by prolonging the cut of the existing stands, as will be discussed later.

Because of the climatic and other conditions just mentioned, maintenance of forest cover and continued forest production in the Rocky Mountain region depend very largely upon public ownership and management of the bulk of the forest resource. In most localities there is a marked tendency toward returning to public ownership of one form or another the scant area now in private ownership. Nevertheless it is desirable that private ownership continue, where it is feasible.

EXTENT TO WHICH PRIVATE OPERATORS ARE PRACTICING FORESTRY

The measure of effectiveness in fire protection necessary to continued forest productivity has been reached on very few private forest properties in this region. Until the period of severe curtailment of lumber production, starting in 1930, fire-protective efforts were constantly increasing. Ten large companies and a much greater number of small owners in the region are reported to the United States Forest Service as having 5,618,489 acres under organized protection in 1931. The reports, it is believed, do not cover the entire private protective effort. The methods used include cooperation with Federal and State forestry organizations, cooperative action among owners through associations, and, to a lesser extent, organization for protection of individual properties.

Reports received show that six operators, owning 890,334 acres, are practicing selective cutting, planting, and other measures (in addition to fire protection) calculated to prolong forest productivity. The practice of selective cutting is based generally on the knowledge that cutting the smaller trees leads to current losses. It is probable that owners of a considerable area not included in these reports, largely in small holdings, are cutting selectively. No cases of definite

committal to sustained-yield practice are reported in the Rocky Mountain region. The measures taken on certain properties in north Idaho are adequate preliminary steps in this direction providing sustained yield is decided on without too much delay and mill capacity is adjusted to the producing capacity of the forests.

Aside from fire-protective effort, which is of great importance and in the northern section is very costly, it is readily observable that private forestry effort is limited to a very small proportion of the areas in private ownership in this region.

PRODUCTION AND CONSUMPTION OF FOREST PRODUCTS

Because population is rather sparse in the Rocky Mountain region, the regional market for forest products does not require large volumes. The United States Forest Products Census of 1928 yielded the following statistics on lumber production and consumption in the region:

TABLE 10.—*Production and consumption of lumber in the Rocky Mountain region*

State	Production [1]	Consumption [2]	State	Production [1]	Consumption [2]
	M board feet	*M board feet*		*M board feet*	*M board feet*
Idaho	977,468	211,698	Arizona	158,047	84,523
Montana	387,879	266,641	New Mexico	162,030	110,034
Wyoming	24,402	134,669			
South Dakota	53,967	174,378	Rocky Mountain region	1,843,673	1,338,121
Utah	7,623	128,066			
Colorado	72,257	228,112			

[1] Data from Forest Products, 1928: Lumber, lath, and shingles. Bureau of the Census, 1930.
[2] Figures based on compiled data in the files of the Forest Service.

This shows production of only 505,552 thousand board feet in excess of consumption. Much lumber is shipped in from the Pacific coast region and some from the southern pine region, while lumber of other species is shipped out. In the long run the prospects are that production will not exceed consumption. In addition to lumber consumption, large quantities of timbers, poles, and posts are required by industries including mines, public utilities, railroads, grazing, and agriculture. In many localities wood is used as fuel. This creates a possibility of balanced use of forest raw material within the region, whereby large-sized trees are used for saw logs while the tops of such trees and smaller trees from thinnings, of small-size species, and from areas where timber does not develop to saw-log size are available for the uses which require only small sizes.

RELATION OF FOREST USE TO REGIONAL ECONOMIC CONDITIONS

Current economic history has brought sharply to our attention the great advantages held by localities having diversified industries. Such localities, being able to carry on local exchanges of their varied products, suffer far less from dislocation of prices and of other economic factors than do single-industry regions dependent on exchanging products with distant regions or in foreign trade. The question of diversification has special significance in a region subject, as is the

Rocky Mountain region, to high transportation costs on both its imports and its exports.

Thus it is of first-rate importance to the region, both as producer and as consumer of forest products, that the productivity of its forests

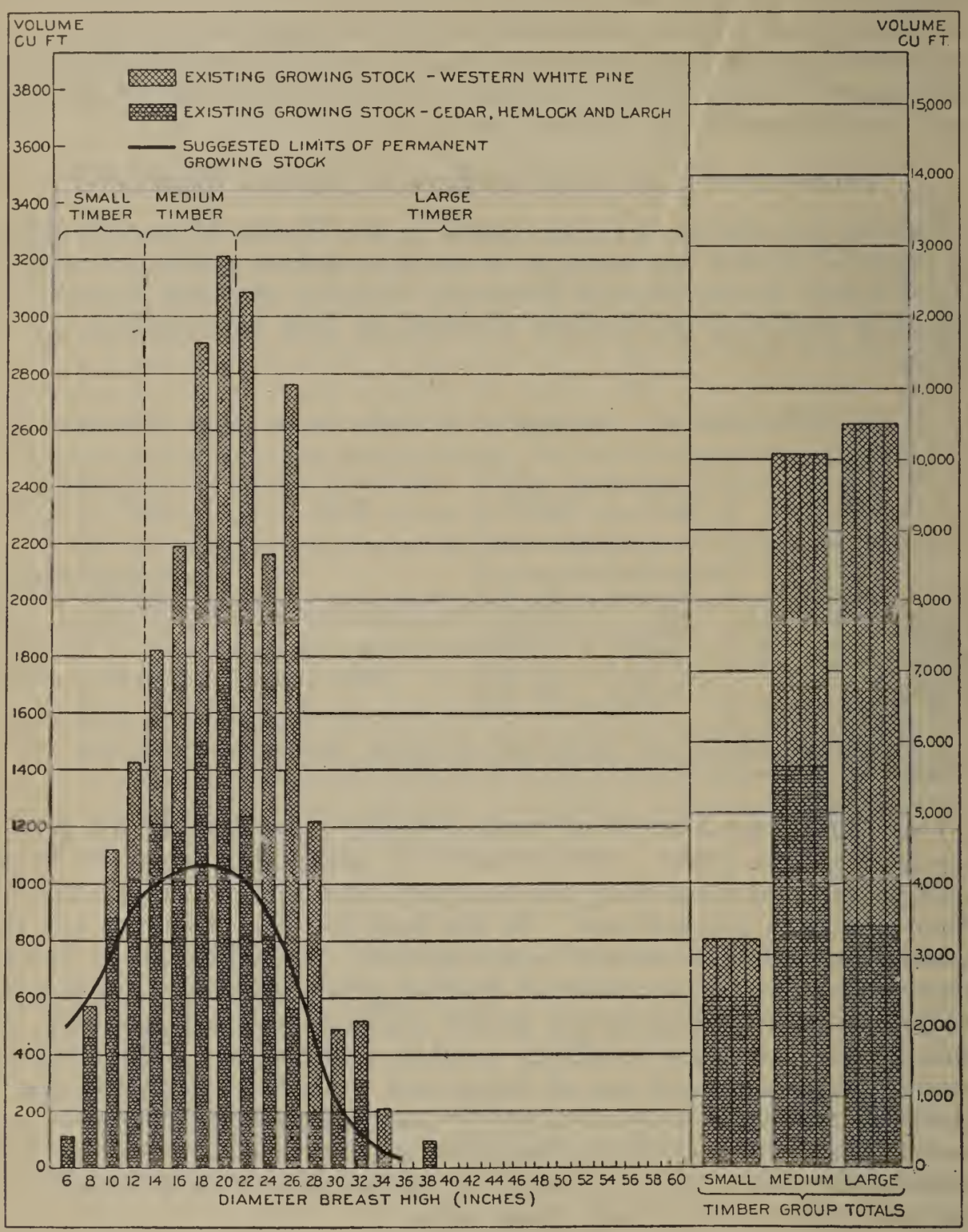

FIGURE 10.—Distribution of cubic volume by diameter classes on heavily stocked acre, site 1, western white pine with cedar, hemlock, and larch, Kaniksu National Forest, Idaho. Future management aims at converting stand more largely to white pine without eliminating subordinate species entirely. In the gradual adjustment of the stand to the limits suggested, inferior species should share cuttings with the white pine.

and the vitality of its forest industries be maintained. The question of the type of ownership necessary to give stability to forest productivity and use should, therefore, be settled as speedily as possible. Permanent division between public and private ownership cannot well be made until the risks that surround private forest ownership are definitely limited.

CONDITION OF TYPICAL TIMBER STANDS AND MANAGEMENT METHODS SUGGESTED

The private-forestry possibilities of the region fall almost entirely within two forest types—the western white pine mixed with other conifers, occurring principally in northern Idaho, western Montana, and northeastern Washington; and the ponderosa pine type, which is distributed in numerous localities throughout the region.

WESTERN WHITE PINE

No data are available for an average example of the western white pine type. The stand shown in figure 10 and table 11 is unusually heavy, having 12,332 cubic feet of western white pine and 11,608 cubic feet of western red cedar, western hemlock, and western larch, or 23,940 cubic feet in all (*21*). It is a very interesting example of an association of species having complementary characteristics such as the shallow rooting and shade endurance of hemlock and cedar and the somewhat deeper rooting habit and need for full light of the pine and larch. On areas occupied by such associations the fullest possible use is made of the site, and vegetative activity is confined almost entirely to the growth of the tree species. For these reasons the stands pile up a very heavy wood volume per acre; the volume in this case exceeds that in most of the examples given for the heavy Pacific Coast forests. If the forest is broken up into the selective form it is necessary to provide for a permanently heavy stocking. Unless stocking is maintained, the productivity of the site will be diverted to shrubs and to seedlings and saplings of the inferior species.

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TABLE 11.—*Number of trees and volume, in 140-year-old heavily stocked western white pine stand, in Kaniksu National Forest, Idaho*

Tree diameters at breast height	Trees per average acre					Gross cubic volume [1]					Gross saw-timber volume [1]				
	White pine	Western red cedar	Western hemlock	Western larch	Total	White pine	Western red cedar	Western hemlock	Western larch	Total	White pine	Western red cedar	Western hemlock	Western larch	Total
Small timber:	*No.*	*No.*	*No.*	*No.*	*No.*	*Cu. ft.*	*Cu. ft.*	*Cu. ft.*	*Cu. ft.*	*Cu. ft.*	*Ft. b.m.*	*Ft. b.m.*	*Ft. b.m.*	*Ft. b.m.*	*Ft. b.m.*
6 inches		17.7	1.3		19.0		106.20	5.20		111.40		327	16		343
8 inches	8.0	36.3	2.7		47.0	112.00	435.60	25.65		573.25	386	1,502	88		1,976
10 inches	9.7	37.7	3.7	1.0	52.1	237.65	791.70	69.56	21.00	1,119.91	914	3,045	268	81	4,308
12 inches	11.0	25.0	1.7	4.3	42.0	415.80	820.00	52.36	141.04	1,429.20	2,009	3,961	253	681	6,904
Total	28.7	116.7	9.4	5.3	160.1	765.45	2,153.50	152.77	162.04	3,233.76	3,309	8,835	625	762	13,531
Medium timber:															
14 inches	11.3	15.0	2.7	8.7	37.7	611.33	687.00	126.63	398.46	1,823.42	3,396	3,817	704	2,214	10,131
16 inches	13.7	11.3	.7	7.0	32.7	1,011.06	697.21	46.55	431.90	2,186.72	5,947	4,101	274	2,541	12,863
18 inches	14.7	7.0	2.0	9.7	33.4	1,396.50	556.50	183.00	771.15	2,907.15	8,728	3,478	1,144	4,820	18,170
20 inches	12.0	7.7	1.0	9.3	30.0	1,422.00	756.91	120.80	914.19	3,213.90	8,888	4,731	755	5,714	20,088
Total	51.7	41.0	6.4	34.7	133.8	4,440.89	2,697.62	476.98	2,515.70	10,131.19	26,959	16,127	2,877	15,289	61,252
Large timber:															
22 inches	12.7	2.7	1.3	6.0	22.7	1,846.58	323.46	198.51	718.80	3,087.35	11,913	2,087	1,281	4,637	19,918
24 inches	7.7	.7	1.0	3.7	13.1	1,345.19	99.68	190.40	526.88	2,162.15	8,850	656	1,253	3,466	14,225
26 inches	10.7	1.0	1.0	1.0	13.7	2,196.71	167.30	233.40	167.30	2,764.71	14,548	1,108	1,546	1,108	18,310
28 inches	4.3	.3	.3	.3	5.2	1,018.24	57.72	82.92	57.72	1,216.60	6,788	385	553	385	8,111
30 inches	1.0	1.0			2.0	270.30	217.20			487.50	1,802	1,448			3,250
32 inches	.7	1.3			2.0	212.80	313.30			526.10	1,419	2,089			3,508
34 inches	.7				.7	236.60				236.60	1,577				1,577
36 inches															
38 inches		.3			.3		94.98			94.98		633			633
Total	37.8	7.3	3.6	11.0	59.7	7,126.42	1,273.64	705.23	1,470.70	10,575.99	46,897	8,406	4,633	9,596	69,532
Total for average acre	118.2	165.0	19.4	51.0	353.6	12,332.76	6,124.76	1,334.98	4,148.44	23,940.94	77,165	33,368	8,135	25,647	144,315

[1] No defect deducted.

In view of the silvicultural desirability of this mixture it is unfortunate that some of the species are of inferior value. This is especially true of the hemlock and white fir, which are not only intrinsically of low value in the region but very defective as well. The growth of the subordinate species, however, is probably in considerable measure a surplus over what can be produced by pine alone. It seems necessary, therefore, to perpetuate the mixture, striving to increase the pine with cedar as a preferred understory.

By what method this type should be managed is a somewhat controversial question. The selection system is here suggested. Although the type is very productive there are a number of difficult management problems to be solved. The growing stock cannot be brought by one cutting to the volume suggested in figure 10 as permanently desirable. A series of cuttings, preferably at intervals of not more than 10 years, is indicated, though present practice contemplates intervals of 20 years or more. Where permanent main transportation systems can be maintained combined with the prevailing combinations of tractor and horselogging no very serious additional costs are created by short cutting cycles. The utilized yield is almost invariably increased through cutting, at each return to the area, trees that would die and decay in the interval of a long cutting cycle. If white pine is to be maintained in the stand it will be necessary to make small openings at each cutting so that pine can seed in. The white pine areas of the Rocky Mountain region lack balance in their wood-using industries and it is therefore difficult to dispose of the inferior material. Owing to this difficulty, in the early cuttings the openings to encourage pine reproduction must necessarily be located where pine makes up most of the stand. It is reasonable to expect the market for inferior species to improve with time. Defective trees constitute an additional silvicultural problem. Where they occur in groups to be cut they should be felled and destroyed with the slash. When the new stand on cut-over spots has developed to seed-bearing age the remainder of the old stand can be removed more freely than in the early cuttings, if in the meanwhile a market has developed for the remaining subordinate species.

Owing to the heavy costs of blister-rust control, effective fire control, the elimination of defective inferior species, etc., forestry in the western white pine type is somewhat expensive. The high value of white pine together with its high rate of productivity justify these costs, at least on the better sites. Intensive methods are indicated as the cheapest means of production.

PONDEROSA PINE

Conditions in the ponderosa pine type are somewhat as shown in figure 9 for eastern Oregon. Large areas where rainfall is especially deficient have much smaller stands per acre than those shown and very slow rates of growth. Successful management of these areas depends on keeping capitalization low, utilizing conservatively both the grazing and the timber returns, and through a policy of very light cuttings insuring natural regeneration and development of trees to merchantable size with very little direct money outlay.

DESIRABLE CHANGES IN MANAGEMENT POLICY

As in other regions, the policy of hasty liquidation is causing heavy losses in lumbering operations. In the application of this policy there has been much overbuilding of manufactuirng plants, so that further heavy losses will undoubtedly result from inability to recover plant investments through operation. The full extent of such losses does not appear until the end of the operating period. These losses may be much reduced through prolonging the timber cut and consequently the useful life of the dependent manufacturing plants.

Intensive logging and milling studies have shown that in the Rocky Mountain region, as in others, a large proportion of the trees cut in current practice are logged and milled at a loss. Figure 11 (*22*) shows

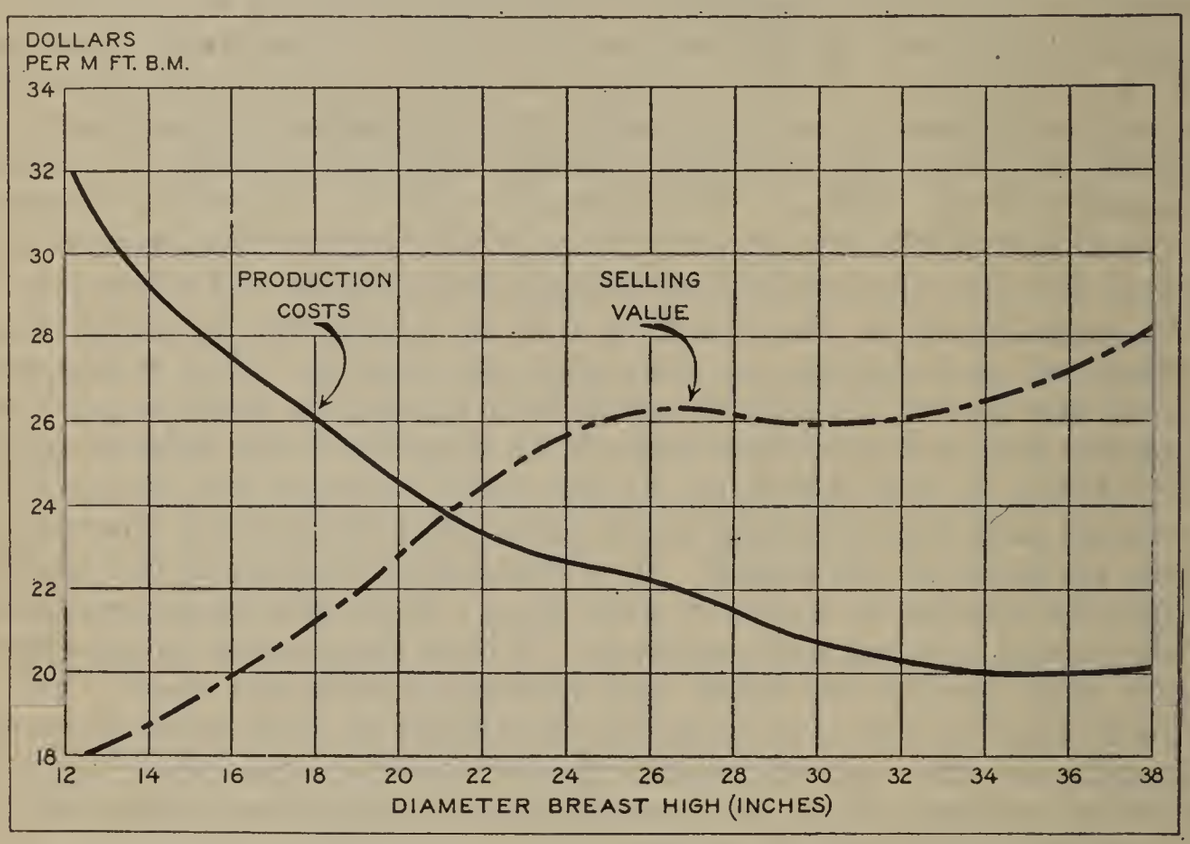

FIGURE 11.—Production costs versus selling value of Ponderosa pine, 1931.

that in a typical ponderosa pine operation in 1931, all trees less than 20 inches in diameter cost more to log and manufacture than sales of lumber returned. In practice it is unwise to cut under 24 inches except to remove smaller trees undesirable for the future stand. If that limit is observed the stand remaining will contain sufficient growing stock to add a considerable volume before the next cut, 15 to 30 years later. Deferred cutting of the trees that can yield no profit now would result in more orderly delivery of the timber from these forests to the market, give more time for local consumers to absorb a large portion (especially of the cheaper grades), allow the national market to be cleared of the surpluses now arising from liquidating privately owned forests, and permit the residual stands to gain in volume and quality and thus in stumpage price. It is readily understandable that in some cases financial and other factors place considerable difficulties in the way of the adoption of these changes in policy.

FORESTS OF THE SOUTH

(Virginia, North Carolina, South Carolina, Georgia, Florida, Alabama, Mississippi, Louisiana, Arkansas, Texas)

PRESENT CONDITIONS AND MANAGEMENT POLICIES

The estimated area of privately owned forest land in the South is 187,264,000 acres, of which 57,866,000 acres is in farm woodlands. The forest area in public ownership is small. Commercially valuable species of pines are found throughout the South, making it the most extensive pine region in the world. In river bottom lands and swamps and at the higher altitudes occur considerable areas of hardwoods. Most of the land in the region is level or only gently sloping, which makes extraction of timber from the forests very simple.

Cutting has been carried on entirely without regulation, and as a rule with little regard to the future effect on the forest. As might have been expected, under this practice the forest productivity has suffered severely. According to the best estimates (see table 1), 43,229,000 acres are in poor to nonrestocking condition and 36,802,000 acres contain a fair amount of young growth but lack larger growing stock. Of the areas having immediately effective growing stock, 52,013,000 acres bear timber of cordwood size and only 55,220,000 bear saw timber, much of which is second growth. On the saw-timber areas the growing stock is very seriously depleted.

As in other regions, three grades of forest-management effort are considered.

1. Fire protection: Elsewhere in this report detailed data on fire protection are presented. In proportion to the areas involved, fire-protective effort is less widespread in the South than in other regions. Undoubtedly the southern pines, on account of greater resistance to injury from fire, are more productive in the absence of fire protection than most commercial species of other regions. They vary among themselves in this respect, and some types suffer from fire more than others. Hardwoods, whether mixed with the pines or in pure stands, are severely damaged by fire.

The areas of 1,000 acres or more reported to be under private protection in this region are as follows: Virginia, North Carolina, and South Carolina, 1,441,748 acres; remainder of the region, 7,760,000 acres; total, 9,201,748 acres. In addition there are large areas of farm woodlands which because of their isolated situation or the efforts of the owners are protected from fires. Public efforts are extending protection to much larger areas.

2. Conservative cutting, planting, leaving seed trees, and other practical measures for improving production, without definite plans for sustained yield, are reported to be practiced on the following areas: Virginia, North Carolina, and South Carolina, 662,500 acres; remainder of the region, 2,092,500 acres; total, 2,755,000 acres.

3. Permanent forest land management and organized plans for sustained yield (by a somewhat liberal construction) may be said to be in effect on the following aggregate areas: Virginia, North Carolina, and South Carolina, 5,000 acres; remainder of the region, 1,349,000 acres; total, 1,354,000 acres. Large additional acreages are in condition to warrant putting them on a definite sustained-yield basis. To do this would necessitate systematizing the operations already

more or less commonly carried on to improve future production and placing a close control on expenditure, income, and maintenance of capital values.

The Southern Forest Experiment Station estimates (*23*) that the following areas in the several types should be under intensive management within 20 years:

	Acres
Longleaf-slash-pine type	6, 340, 000
Shortleaf-loblolly-hardwood type	9, 715, 000
Riverbottom hardwood and cypress type	2, 710, 000
Total	18, 765, 000

The sustained yield area noted above is included in these areas.

PRODUCTION AND CONSUMPTION OF FOREST PRODUCTS

Settlement of the South occurred early in the history of the Nation. In consequence of the fact that other regions of the United States were well supplied with forests until nearly the end of the nineteenth century, a large timber industry beyond the needs of the region and of some coastwise and export trade did not develop until about 1880. Annual production then increased rapidly to a maximum in 1909 of nearly 20 billion board feet. The region now supplies more than one third of the Nation's softwood lumber, and more than one half of its hardwoods. The relation between production and consumption is shown for each State and for the region as a whole in table 12.

TABLE 12.—*Lumber production and consumption in the South in 1928*

[In thousand board feet]

State	Production [1]			Consumption [2]
	Softwood	Hardwood	Total	
Virginia	352, 049	195, 657	547, 706	451, 685
North Carolina	787, 616	233, 277	1, 020, 893	620, 130
South Carolina	660, 025	161, 875	821, 900	126, 755
Georgia	888, 437	151, 038	1, 039, 475	364, 740
Florida	933, 514	61, 558	995, 072	416, 106
Alabama	1, 731, 783	248, 299	1, 980, 082	526, 092
Mississippi	2, 085, 097	439, 222	2, 524, 319	436, 316
Louisiana	1, 550, 414	728, 008	2, 278, 422	707, 880
Arkansas	659, 149	470, 582	1, 129, 731	400, 725
Oklahoma	174, 957	18, 836	193, 793	456, 288
Texas	1, 217, 361	229, 325	1, 446, 686	1, 588, 051
Total	11, 040, 402	2, 937, 677	13, 978, 079	6, 094, 768

[1] Data from Forest Products, 1928: Lumber, lath, and shingles. Bureau of the Census, 1930.
[2] Figures based on compiled data in the files of the Forest Service.

The South's surplus in 1928 of 7,883,311,000 board feet over its own consumption slightly exceeded that of the Pacific coast region.

Although lumber is the outstanding forest product of the South, many others are of great importance. The longleaf- and slash-pine belt is the sole source of naval stores in the United States and produces greater quantities of naval stores than any other region in the world. In recent years a large pulp and paper industry has developed. Poles, posts, and piling are produced on a considerable scale for local use and for shipment to other regions.

As against the surplus over regional requirements of nearly 8 billion feet of lumber and large volumes of other forest products should be considered the requirements of a great belt of States stretching from the prairies of the upper Mississippi Valley through the Lake and Central States to the coast of New England and the Middle Atlantic States. The forests of these States lack nearly 15 billion feet of producing sufficient lumber for local use, not to mention other forest-products requirements. Moreover, the forests of these States now consist mostly of hardwoods, while the South produces great quantities of conifers. Numerous railroad lines, together with water routes, provide adequate transportation between the regions.

This situation has been so favorable for the southern forest industries that production has gone on as a matter of course without much thought of the continuity of the supply. The certain evidences of decline in production justify a change in policy by all agencies concerned. The need is for organized forest management, which in comparison with chance or hit-and-miss methods produces just as superior results as organized effort does in other fields of business.

FINANCIAL ASPECTS OF FOREST USE

Because of its vast land area, the South has a potential productivity for its characteristic agricultural crops that far exceeds market possibilities. Diversification of industry into other fields is thus peculiarly necessary. The wide distribution of forest stands has made the forest industries the outstanding supplement of agricultural activity. Forest industries have supplied employment, and an oulet for timber from farm woodlands, the loss of which would be calamitous to the region. The region's naval-stores industry, its recently developed pulp industry, and its outlets for posts, poles, and piling make for balance in demand for forest raw material; it cannot be said, however, that the possibilities of such balance have been worked out with much refinement. The naval-stores industry is destroying timber unnecessarily in its operations. The pulp industry, though using considerable mill and forest waste, is responsible for the premature cutting of considerable areas of young growth, destroying the stands as they enter the period of greatest increase in value. At present the pulp industry is obtaining material at very low cost, the forest owner receiving practically no return for the use of his property. If pulpwood material were taken in thinnings the landowner, though receiving only labor costs or slightly more, as at present, would be compensated by the production of higher-priced material to be cut later. Under this procedure the pulp industry would perpetuate its command of low-cost raw material.

Information accumulated by the Forest Taxation Inquiry indicates that the value of the forest land and stumpage in the South totals about $1,595,477,000 (*24*). Accurate data on mill and logging investments are not available. Much of the cut is now being made by small mills. In recent years investments in larger mills have declined in value. The future of both types of investments depends directly on the foresight and skill with which forest owners, managers, and technicians handle the forests. Beyond these factors public attitudes are of great importance in establishing a favorable setting for forward-looking policies. The forest as a resource is so exposed to public

action through taxation, through the uncontrolled use of fire, and in other ways that the management efforts of the forest owner are likely to be in vain when the public attitude is adverse or even indifferent.

In the South the huge forest area and the ease of forest regeneration create a situation in which cutting alone would create no immediate danger of an excessively low rate of yield. Owing to the largely unrestricted use of fire, however, the loss of productivity is considerable. Soil conditions over large areas are such as to permit alternative use for forestry or agriculutre. Much land formerly used for agriculture has been taken over by timber. A survey of Union Parish, La. (*25*), showed that 18 percent of the forests were old-field stands. In the future there will probably be further changes from agricultural

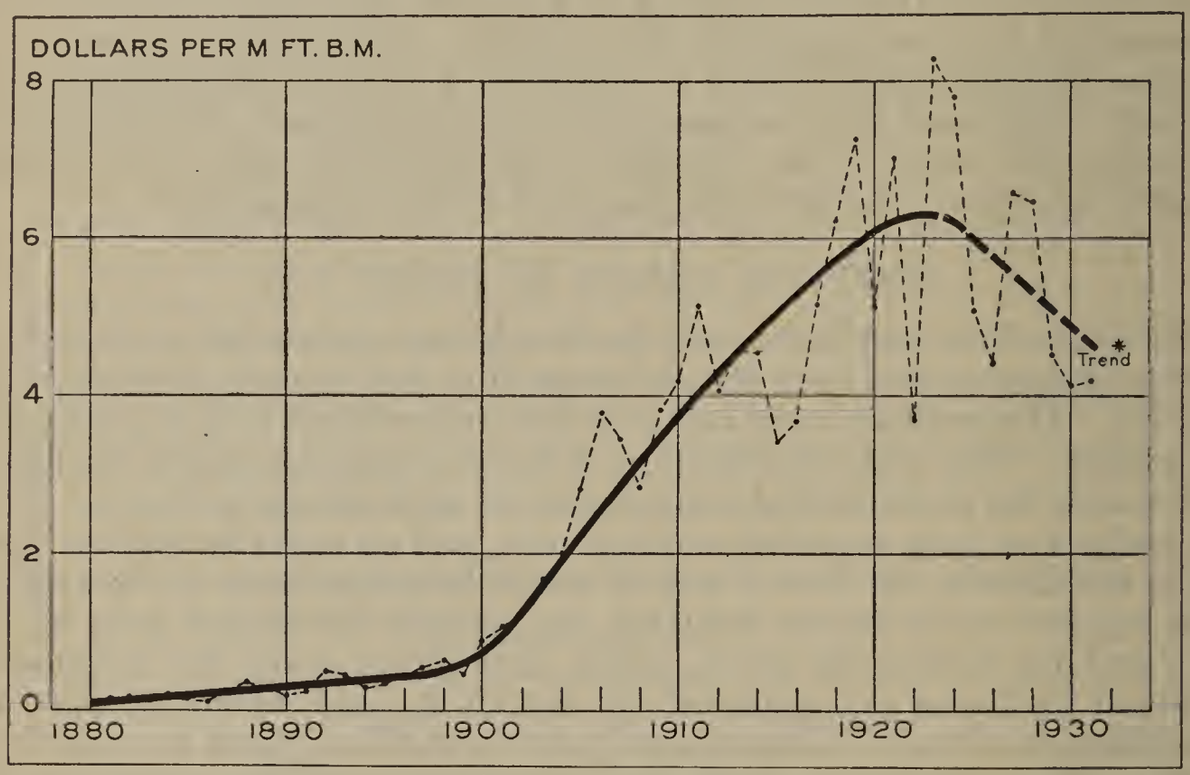

FIGURE 12.—Stumpage price of southern yellow pine, Louisiana, Texas, Alabama, Mississippi, Florida-Georgia, 1880–1931 (compiled by U.S. Forest Service from sales of 86 billion feet of privately owned timber). The broken line 1923–31 represents the trend during the deflation period subsequent to the World War. The inclusion of data for future years may materially change this portion of the general trend. In fact the slight increase of 1931 over 1930 may indicate that the upturn has commenced. Includes since 1900 sales of approximately 3 billion feet of second-growth pine.

to forest use and from forest to agricultural use. It is conceivable that on soils where the fertility has been impaired forest crops will be grown for the definite purpose of restoring fertility needed for future agricultural use.

STUMPAGE PRICES (*26*)

Based on averages for all the species and grades of southern pine that were being cut commercially in the years since 1880, figure 12 shows graphically the price changes since 1880. It is based on answers to questionnaires of the United States Forest Service since 1921 and on such data as were available prior to that date.

It is interesting to observe the parallel course of price movements in pine stumpage and cotton, two great southern staples. Figure 13 shows by price indexes based on prices of the year 1926 as 100 that since 1929 second-growth pine stumpage has held up in prices better than cotton.

STANDS AND INCREMENTS IN A TYPICAL COUNTY

Data obtained from surveys of counties distributed through the South show that in general the lumber cut must be expected to decline in the next few years. The following statement of the Southern Forest Experiment Station, with table 13, shows the present status in a county where conditions are better than average (*25*):

A county-wide study in the shortleaf- loblolly-pine hardwoods in northern Louisiana yielded the data set out in the following tabulation of second-growth

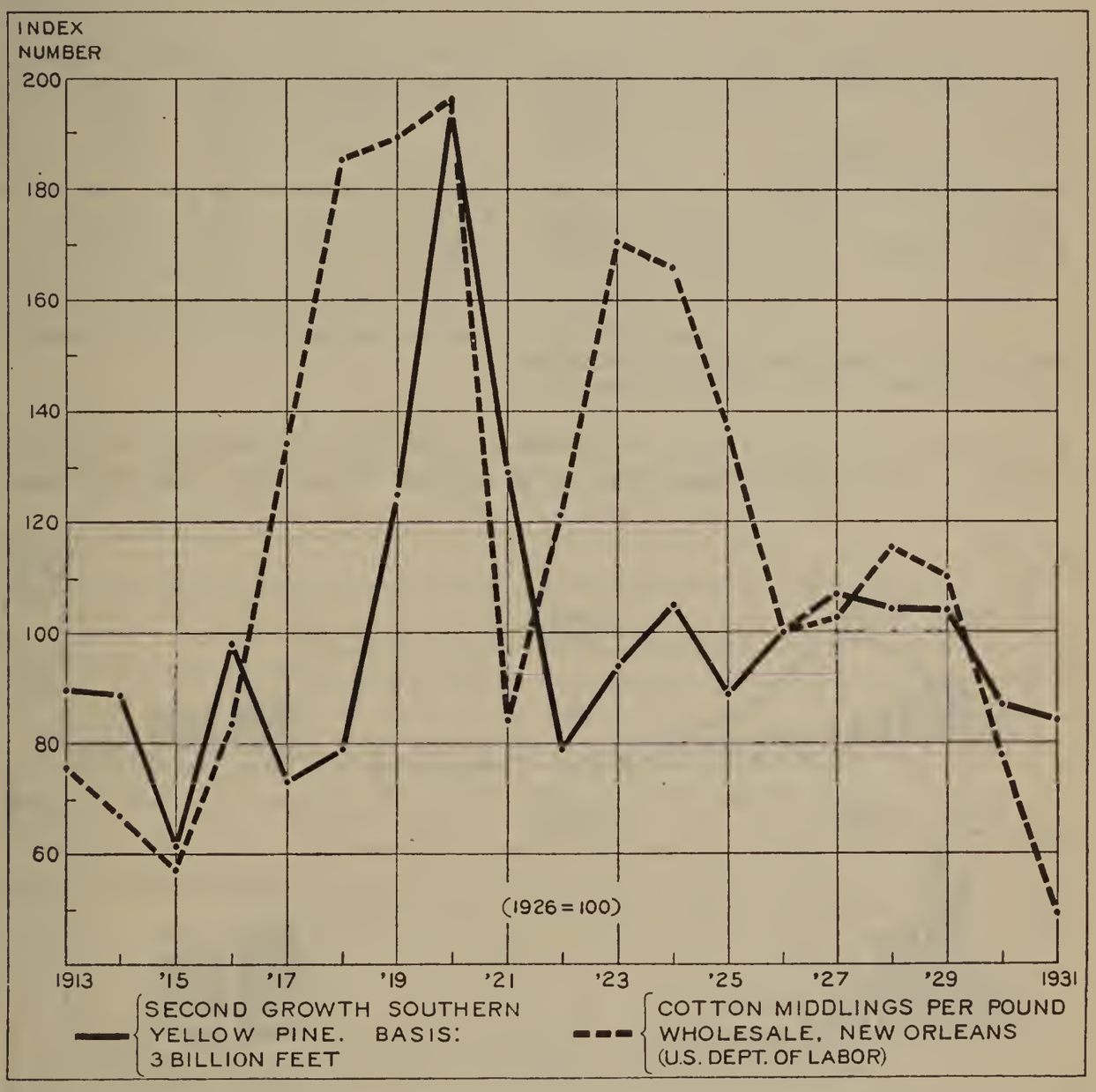

FIGURE 13.—Comparison of price indexes of cotton and second-growth southern yellow pine stumpage.

stands and current annual increment. These data show actual conditions as they exist on certain areas of better forest lands, except that the percentage of old-field stands, and hence the rate of growth, in this county is considerably above the average. In the average county the percentage of old-field stands probably does not exceed 5. The better stands of this county show conditions favorable for private commercial forestry operations. The trees making up each old-field stand are fairly even aged, but the stands vary widely in age. However, a merchantable old-field stand with trees practically even aged has a considerable range of diameter classes. Most of the second-growth stands have been cut two or more times, and the trees vary considerably as to age and usually have a good distribution of diameters.

TABLE 13.—*Timber stands and current annual increments, by classes of stands, in Union Parish, La.*[1]

Class of stand	Area	Proportion of forest area in county	Pine volume per acre [2]		Current annual increment of pine per acre [2]	
			Trees 9 inches or more in diameter breast high	Trees 13 inches or more in diameter breast high	Trees 9 inches or more in diameter breast high	Trees 13 inches or more in diameter breast high
Merchantable second-growth pine:	*Acres*	*Percent*	*Board feet*	*Board feet*	*Board feet*	*Board feet*
Well-stocked	28,900	8	10,468	5,618	607	569
Poorly-stocked	83,200	23	2,472	1,207	216	201
Old-field	65,100	18	6,528	3,121	626	425
Pine-hardwood bottom	25,300	7	1,904	1,246	186	186
Cut-over unmerchantable pine:						
Restocking	61,500	17	275	49	55	18
Nonrestocking	25,300	7	323	23	58	19
Denuded	14,500	4	0	0	0	0
Hardwood bottom	57,800	16	0	0	0	0
Total	361,600	100				

[1] Data from the Southern Forest Experiment Station.
[2] Volumes by International one-eighth inch log rule.

The excellent growth in well-stocked stands is worthy of special attention. It is very plain that the owner of poorly stocked stands

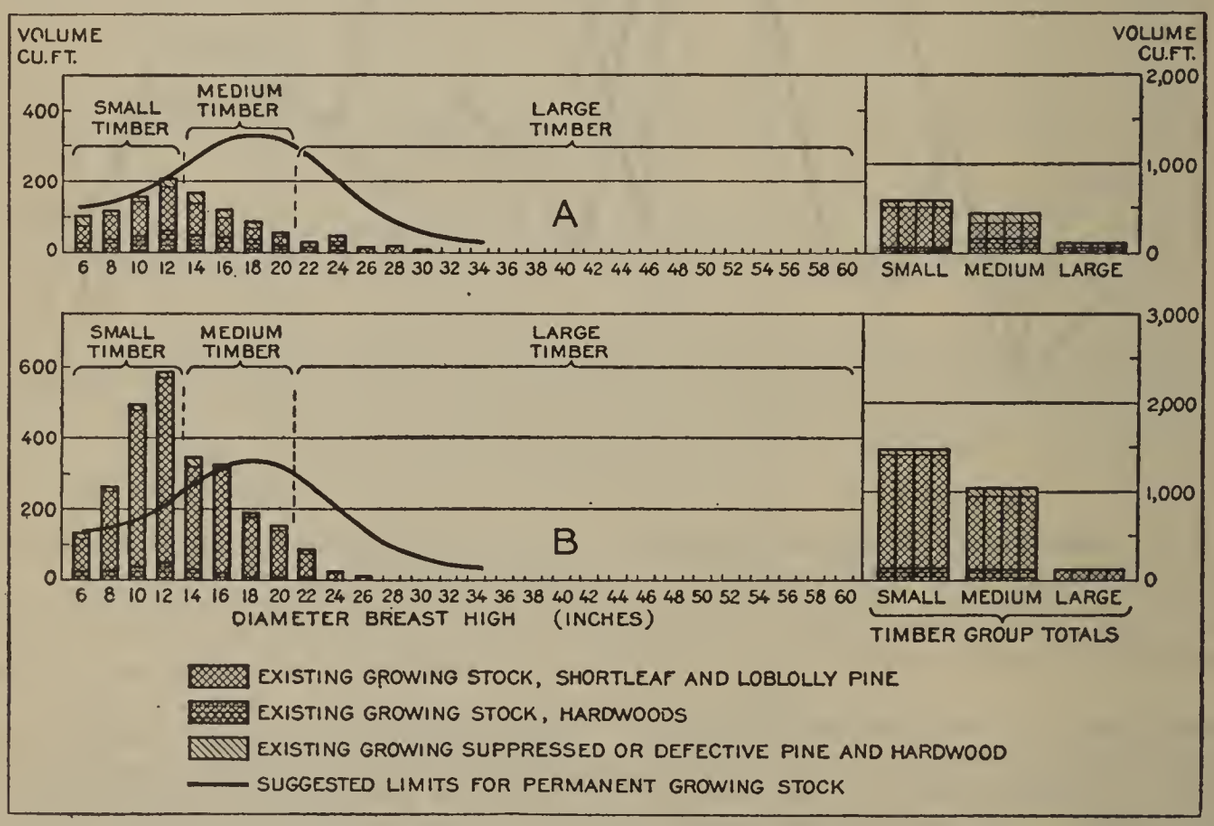

FIGURE 14.—Distribution of cubic volume by diameter classes on average acre of shortleaf-loblolly pine and hardwood stands. A, Poorly stocked stands said to represent average conditions on 7,000,000 acres in southern Arkansas, northern Louisiana, and eastern Texas; B, well-stocked stands average from an inventory of 28,900 acres said to be representative of 600,000 acres in southern Arkansas, northern Louisiana, and eastern Texas. There are sufficient trees in the stand but it should be managed toward a larger proportion of larger size classes.

has to pay taxes and the expenses of fire protection and administration on more than 2 acres to obtain production equal to that of 1 acre of well-stocked stands.

CONDITION OF TYPICAL STANDS, AND MEASURES THAT WILL BUILD UP THEIR PRODUCTIVITY

Investigations of timber growth, surveys of forest conditions in individual counties, and the general forest survey now under way under the direction of the Southern Forest Experiment Station are beginning to yield definite detailed information as to the condition of individual stands. Four cases will be cited.

(1) *Average-stocked shortleaf and loblolly pine with hardwoods.*—It is believed that the problem of building up the stands is simpler with shortleaf and loblolly pine than with longleaf pine, which will be discussed later. It is probable, also, that the total volume per acre of selection forests of these species would normally exceed that of longleaf. Figure 14, diagram A, and table 14 show conditions in certain stands of this type in southern Arkansas. The acre averages are based on an inventory of 345,000 acres of average-stocked stands in the shortleaf-loblolly-hardwood type and are estimated (*25*) to be typical of conditions on 7 million acres of this type. This area comprises some of the most productive forests of this type and cannot be taken as typical of larger areas of the type.

TABLE 14.—*Number of trees, volume and growth average stocked shortleaf and loblolly pine with hardwood stands in southern Arkansas*

Tree diameters at breast height	Trees per average acre				Time required to grow to next diameter class [1]			Cubic volume [1]				Saw timber volume [1]				Average annual growth of saw timber [2]		
	Shortleaf	Loblolly	Hardwoods	Defective all species	Shortleaf	Loblolly	Hardwoods	Shortleaf	Loblolly	Hardwoods	Total	Shortleaf	Loblolly	Hardwoods	Total	Shortleaf	Loblolly	Total
Young stock:	*Number*	*Number*	*Number*	*Number*	*Years*	*Years*	*Years*	*Cu. ft.*	*Cu. ft.*	*Cu. ft.*	*Cu. ft.*	*Ft.b.m.*	*Ft.b.m.*	*Ft.b.m.*	*Ft.b.m.*	*Ft.b.m.*	*Ft.b.m.*	*Ft.b.m.*
2 inches	3.48	8.31	20.58	6.72	13	10	20	0.35	0.83	2.57	3.75							
4 inches	4.51	10.35	12.59	7.23	12	10	20	4.92	9.32	10.95	25.19							
Total	7.99	18.66	33.17	13.95				5.27	10.15	13.52	28.94							
Small timber:																		
6 inches	4.77	8.24	11.78	4.16	12	9	15	17.84	28.68	28.74	75.26	52	124		176	10.5	16.8	27.3
8 inches	3.94	5.02	6.96	1.76	12	9	14	33.25	39.56	38.28	111.09	118	136	42	296	17.8	21.0	38.8
10 inches	3.18	3.97	4.28	1.07	11	8	14	48.46	55.26	45.45	149.17	235	238	180	653	21.0	32.5	53.5
12 inches	2.02	3.19	3.63	1.23	11	8	14	48.48	75.28	64.98	188.74	269	364	323	956	13.7	32.5	46.2
Total	13.91	20.42	26.65	8.22				148.03	198.78	177.45	524.26	674	862	545	2,081	63.0	102.8	165.8
Medium timber:																		
14 inches	.85	1.51	1.95	1.01	11	8	14	30.26	52.85	53.41	136.52	177	290	287	754	6.2	20.0	26.2
16 inches	.27	.84	1.23	.58	11	7	14	13.04	40.74	47.90	101.68	77	234	271	582	2.1	14.7	16.8
18 inches	.12	.37	.78	.46	12	7	14	7.72	23.68	41.14	72.54	46	144	242	432	1.0	6.3	7.3
20 inches	.04	.23	.42	.17	12	7	14	3.26	18.31	28.87	50.44	20	117	178	315		4.2	4.2
Total	1.28	2.95	4.38	2.22				54.28	135.58	171.32	361.18	320	785	978	2,083	9.3	45.2	54.5
Large timber:																		
22 inches	.01	.10	.12	.15	12	6	15	.99	9.70	10.47	21.16	6	64	68	138		2.1	2.1
24 inches		.05	.26	.15		6	15		5.75	28.92	34.67		39	196	235		1.0	1.0
26 inches		.02	.02	.02		6	15		2.65	2.80	5.45		18	20	38			
28 inches			.06	.02			15			10.44	10.44			79	79			
30 inches			.02	.01			16			4.20	4.20			34	34			
Total	.01	.17	.48	.35				.99	18.10	56.83	75.92	6	121	397	524		3.1	3.1
Total for average acre	23.19	42.20	64.68	24.74				208.57	362.61	419.12	990.30	1,000	1,768	1,920	4,688	72.3	151.1	223.4

[1] Defective trees not included.

[2] Defective trees and hardwood not included. Hardwood is growing at rate of about 80 board feet per acre per annum but defects caused chiefly by fire damage render most hardwoods unmerchantable. Allowance has been made for mortality of about 15 percent of gross annual growth.

(2) *Better-stocked shortleaf-loblolly-hardwood stands.*—Figure 14 (diagram B) and table 15 show stands that are in better condition to yield current returns when organized into forest properties than the average-stocked stands.

The cutting practice necessary to build up stands such as that shown in table 14 to take advantage of their earning possibilities consists in very light cuttings, returning to a given stand about once every 10 years. Not only will an effort be made to increase the number of smaller trees until the ground is as fully occupied as warranted by the characteristics of the species, but at each cut some of the thrifty larger trees will be held for further growth. Younger trees will gradually come up into the small timber class if seed trees of requisite number and age are present and fire does not destroy the seedlings. When the density of the stand has been fully built up cuttings will usually take the form of clean cutting groups and removing single trees as required throughout the intervening stand. Some of these scattered trees will be removed because fully matured in size and value, others will be thinned out of dense groups to give remaining trees more space. Each addition to the growing stock, up to a fairly high density, will add to the growth per acre and reduce the cost of production per 1,000 board feet. Small additions to the growing stock left at each cut insure an accumulation of volume far beyond the additions themselves. In other words, the rebuilding of the growing stock is more a matter of skillful handling than of financial sacrifice.

TABLE 15.—*Number of trees, volume, and growth, exceptionally well stocked shortleaf and loblolly pine with some hardwood stands in southern Arkansas*

Tree diameters at breast height	Trees per average acre					Average time required to grow to next diameter class		
	Shortleaf	Loblolly	Hardwoods	Total stand [1]	Defective, all species	Shortleaf	Loblolly	Hardwoods
Young stock:	*Number*	*Number*	*Number*	*Number*	*Number*	*Years*	*Years*	*Years*
2 inches	3.86	13.31	13.03	30.20	19.31	14	16	23
4 inches	7.17	11.72	7.03	25.92	8.07	12	14	23
Total	11.03	25.03	20.06	56.12	27.38			
Small timber:								
6 inches	9.10	13.38	9.10	31.58	5.93	12	12	18
8 inches	10.14	14.90	5.31	30.35	1.79	12	11	17
10 inches	12.21	14.28	4.69	31.18	1.32	12	10	17
12 inches	9.52	10.34	2.83	22.69	.76	13	9	17
Total	40.97	52.90	21.93	115.80	9.80			
Medium timber:								
14 inches	3.17	4.69	.96	8.82	.76	15	9	17
16 inches	1.24	4.34	.62	6.20	.69	17	8	17
18 inches	.34	1.66	.83	2.83	.35	19	8	17
20 inches	.14	1.17	.41	1.72	.14	20	8	17
Total	4.89	11.86	2.82	19.57	1.94			
Large timber:								
22 inches	.07	.62	.07	.76	.14	20	8	18
24 inches		.14	.07	.21	.07		8	18
26 inches		.07		.07			8	18
28 inches					.07			
Total	.07	.83	.14	1.04	.28			
Total for average acre	56.96	90.62	44.95	192.53	39.40			

TABLE 15.—*Number of trees, volume, and growth, exceptionally well stocked shortleaf and loblolly pine with some hardwood stands in southern Arkansas*—Continued

Tree diameters at breast height	Cubic volume [1]				Saw timber volume [1]	
	Shortleaf	Loblolly	Hardwoods	Total	Shortleaf	Loblolly
	Cu. ft.	*Cu. ft.*	*Cu. ft.*	*Cu. ft.*	*Ft. b.m.*	*Ft. b.m.*
Young stock:						
2 inches	0.50	2.00	1.63	4.13	----------	----------
4 inches	8.89	14.06	6.12	29.07	----------	----------
Total	9.39	16.06	7.75	33.20	----------	----------
Small timber:						
6 inches	38.95	54.59	22.20	115.74	109	201
8 inches	96.74	132.01	29.20	257.95	365	477
10 inches	208.79	223.20	49.81	481.80	1,062	957
12 inches	255.14	264.70	50.66	570.50	1,476	1,355
Total	599.62	674.50	151.87	1,425.99	3,012	2,990
Medium timber:						
14 inches	122.04	175.88	26.25	324.17	723	985
16 inches	64.73	223.94	24.14	312.81	386	1,341
18 inches	22.61	113.21	43.77	179.59	136	706
20 inches	11.59	98.40	28.18	138.17	71	638
Total	220.97	611.43	122.34	954.74	1,316	3,670
Large timber:						
22 inches	6.90	62.00	6.11	75.01	43	412
24 inches	----------	16.10	7.79	23.89	----------	109
26 inches	----------	9.19	----------	9.19	----------	64
Total	6.90	87.29	13.90	108.09	43	585
Total for average acre	836.88	1,389.28	295.86	2,522.02	4,371	7,245

Tree diameters at breast height	Saw timber volume [1]		Average annual growth of saw timber [2]		
	Hardwoods	Total	Shortleaf	Loblolly	Total
	Ft. b.m.	*Ft. b.m.*	*Ft. b.m.*	*Ft. b.m.*	*Ft. b.m.*
Young stock:					
4 inches	----------	----------	3.1	3.5	6.6
Small timber:					
6 inches	----------	310	15.8	16.4	32.2
8 inches	32	874	37.3	41.0	78.3
10 inches	197	2,216	60.0	79.2	139.2
12 inches	252	3,083	46.4	78.7	125.1
Total	481	6,483	159.5	215.3	374.8
Medium timber:					
14 inches	141	1,849	15.2	44.7	59.9
16 inches	136	1,863	5.6	54.5	60.1
18 inches	257	1,099	1.6	21.5	23.1
20 inches	174	883	.7	15.3	16.0
Total	708	5,694	23.1	136.0	159.1
Large timber:					
22 inches	40	495	.3	8.3	8.6
24 inches	53	162	----------	1.9	1.9
26 inches	----------	64	----------	1.0	1.0
Total	93	721	.3	11.2	11.5
Total for average acre	1,282	12,898	186.0	366.0	552.0

[1] Defective trees not included.

[2] Defective trees and hardwoods not included. Hardwood is growing at the rate of about 50 board feet per acre per annum but defects caused chiefly by fire render most of hardwoods unmerchantable.

(3) *Longleaf pine* (*23*).—Average and better stocked stands of longleaf and slash pines are graphically represented in figure 15. Diagram A and table 16 are representative of an average stocked stand in Hamilton County, Fla. Diagram B shows a better stocked stand found in Bradford County, Fla. The average stand has about

one third the number of trees present in the better stocked stand. In both cases there is a moderate representation in the small timber group (6 to 12 inches diameter), very little in the medium timber

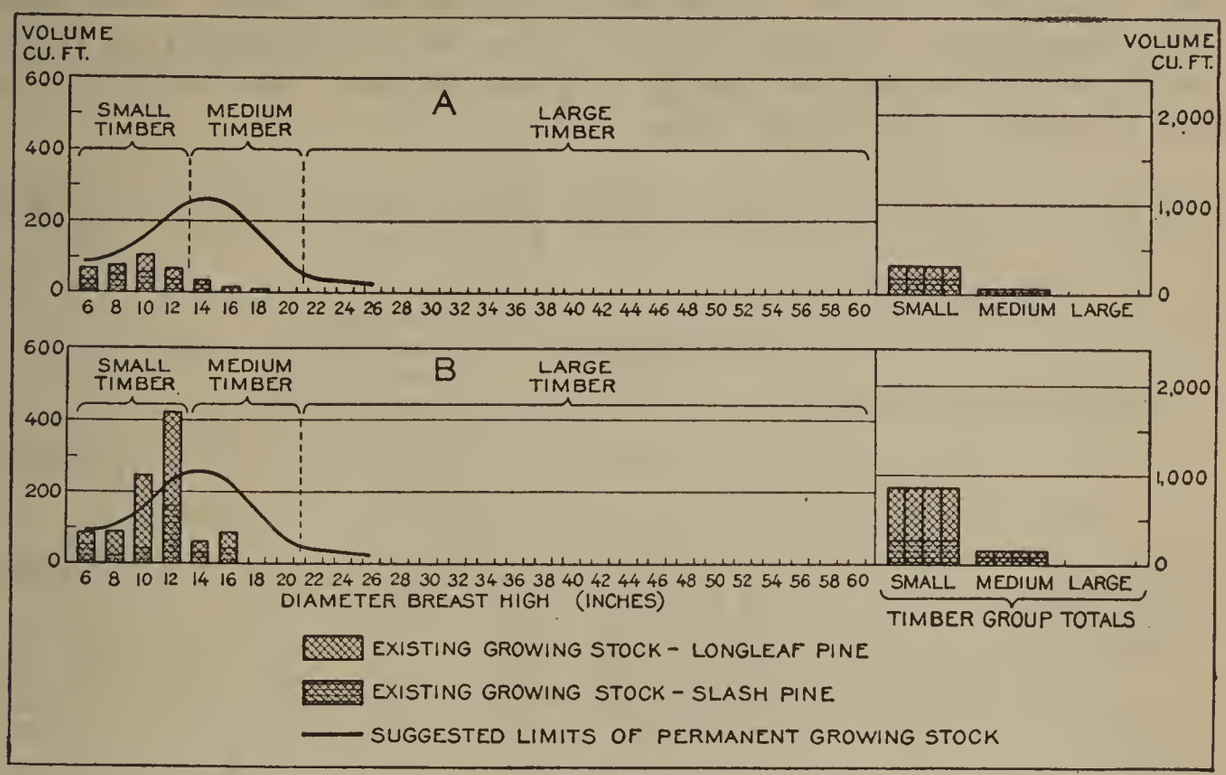

FIGURE 15.—Distribution of cubic volume by diameter classes on average acre longleaf and slash pine stands in naval-stores region. A, Average stocked stand based on sampling of 150,000 acres in Florida, said to be representative of 20,000,000 acres; B, better stocked stand based on inventory of 200 acres and said to be representative of 1,000,000 acres. Only a moderate permanent growing stock is recommended, owing to naval stores yields being higher from well-spaced trees.

group (14 to 20 inches diameter), and no large timber (22 inches diameter and larger).

Authorities hold that considerable areas of longleaf pine sites are too poor and the stands on them too badly depleted to warrant

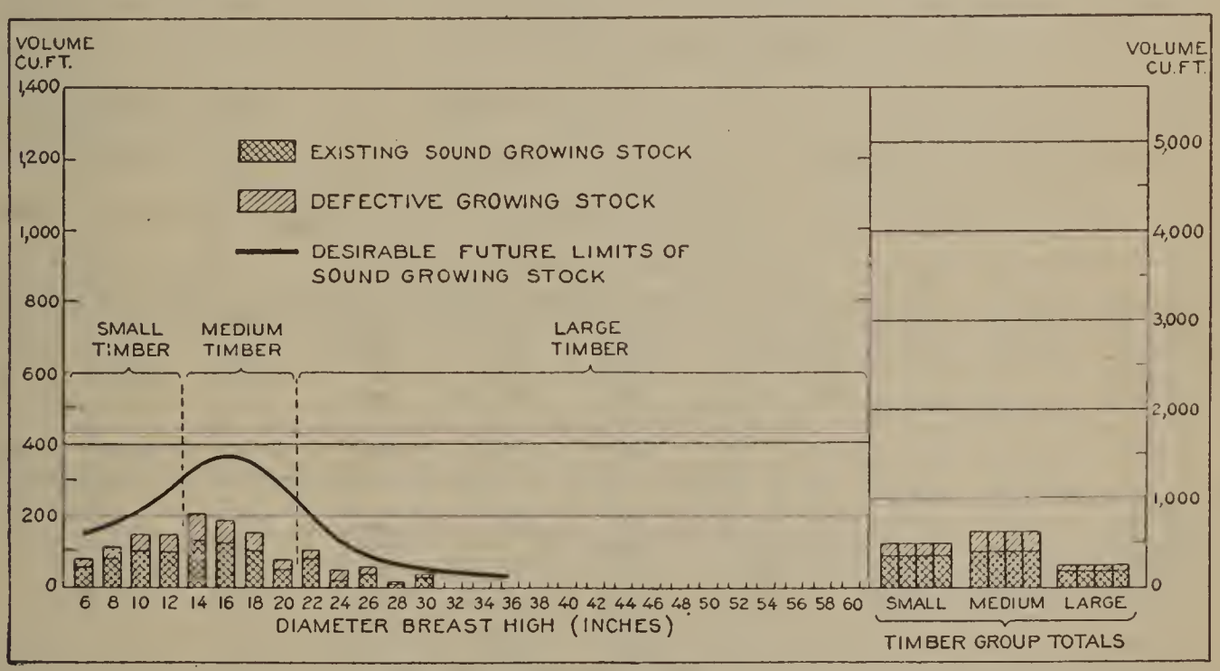

FIGURE 16.—Distribution of cubic volume by diameter classes on average acre in river-bottom hardwoods, based on strip tally of 10,000 acres, considered to be typical of about 25 percent of the 23,070,000 acres in this type.

operation by private capital. On good sites, with inadequate seed trees, planting is the proper procedure. This involves waiting a long time for returns except where plantations are a part of otherwise timbered properties.

(4) *Bottomland hardwoods (28).*—The bottomland hardwood stands include a great variety of hardwood species together with cypress. In table 17 these have necessarily been grouped into the principal genera. Figure 16 shows graphically the cubic-volume distribution of the same stand. These data are based on an inventory of 10,000 acres in south-central Louisiana and are believed to be typical of about 6 million acres in the type.

TABLE 16.—*Number of trees, volume, and growth in average stocked stand of longleaf and slash pine in Florida* [1]

Tree diameters at breast height	Number trees per average acre			Time required to grow to next diameter class		Cubic volume		
	Longleaf	Slash	Total	Longleaf	Slash	Longleaf	Slash	Total
Young stock:	*Number*	*Number*	*Number*	*Years*	*Years*	*Cubic feet*	*Cubic feet*	*Cubic feet*
Under 2 inches	9.28	1.90	11.18					
2 inches	18.02	8.99	27.01	6	6	1.80	0.90	2.70
4 inches	13.06	8.99	22.05	7	7	10.45	7.19	17.64
Total	40.36	19.88	60.24			12.25	8.09	20.34
Small timber:								
6 inches	12.14	13.13	25.27	8	7	36.42	36.76	73.18
8 inches	4.71	8.23	12.94	9	8	22.18	55.14	77.32
10 inches	3.31	4.62	7.93	11	8	45.68	60.06	105.74
12 inches	1.18	2.08	3.26	12	9	25.96	41.60	67.56
Total	21.34	28.06	49.40			130.24	193.56	323.80
Medium timber:								
14 inches	.63	.62	1.25	14	9	19.53	18.60	38.13
16 inches	.16	.24	.40	17	10	7.20	10.08	17.28
18 inches	.04		.04	18	10	2.32		2.32
20 inches	.02	.06	.08	22	10	1.40	4.20	5.60
Total	.85	.92	1.77			30.45	32.88	63.33
Total for average acre	62.55	48.86	111.41			172.94	234.53	407.47

Tree diameters at breast height	Saw timber volume			Average annual growth of saw timber [2]		
	Longleaf	Slash	Total	Longleaf	Slash	Total
Small timber:	*Board feet*	*Board feet*	*Board feet*	*Board feet*	*Board feet*	*Board feet*
6 inches	73	53	126	18.2	26.7	44.9
8 inches	104	189	293	16.1	29.3	45.4
10 inches	209	282	491	12.2	19.0	31.2
12 inches	138	218	356	4.9	9.9	14.8
Total	524	742	1,266	51.4	84.9	136.3
Medium timber:						
14 inches	115	100	215	3.3	4.2	7.5
16 inches	45	59	104	.6	1.7	2.3
18 inches	15		15	.1		.1
20 inches	9	25	34	.1	.3	.4
Total	184	184	368	4.1	6.2	10.3
Total for average acre	708	926	1,634	55.5	91.1	146.6

[1] Said to be typical of 20,000,000 acres in naval stores region. Much of the growth is never utilized for saw timber, owing to use of trees for turpentining.

[2] The growth indicated is an approximation. The mortality was assumed to reduce gross volume growth by 25 percent.

TABLE 17.—*Number of trees, volume, and growth in typical stand second-growth, river bottom hardwoods in lower Mississippi Valley*

Tree diameters at breast height	Trees per average acre						Time required to grow to next diameter class			
	All oaks	Hickories	Gums	All others	Culls [2]	Total stand	All oaks	Hickories	Gums	All others
Young stock:	*Number*	*Number*	*Number*	*Number*	*Number*	*Number*	*Years*	*Years*	*Years*	*Years*
2 inches	30.0	3.0	9.0	12.6	33.4	54.6	9	17	12	13
4 inches	20.0	2.2	7.0	10.8	14.5	40.0	9	17	12	13
Total	50.0	5.2	16.0	23.4	47.9	94.6				
Small timber:										
6 inches	7.5	1.3	3.7	9.9	6.7	22.4	7	12	9	11
8 inches	5.3	.4	1.5	8.7	5.5	15.9	7	12	9	11
10 inches	3.5	.2	.7	7.6	3.7	12.0	7	12	9	11
12 inches	2.2	.2	.7	4.9	3.6	8.0	7	12	9	11
Total	18.5	2.1	6.6	31.1	19.5	58.3				
Medium timber:										
14 inches	2.3	.1	.7	3.3	3.5	6.4	8	13	11	12
16 inches	2.3	.1	.4	1.5	2.1	4.3	8	13	11	12
18 inches	1.80		.30	.45	1.10	2.55	8	13	11	12
20 inches	.65	.05	.10	.35	.45	1.15	8	13	11	12
Total	7.05	.25	1.50	5.60	7.15	14.40				
Large timber:										
22 inches	.55	.10	.35	.30	.35	1.30	8	13	11	12
24 inches	.10			.25	.35	.35	9	17	12	13
26 inches	.15		.15		.20	.30	9	17	12	13
28 inches	.04		.03	.02	.02	.09	9	17	12	13
30 inches							9	17	12	13
32 inches	.06		.06	.03	.05	.15	9	17	12	13
Total	.90	.10	.59	.60	.97	2.19				
Total for average acre	76.45	7.65	24.69	60.70	75.52	169.49				

Tree diameters at breast height	Cubic volume						Saw timber volume	
	All oaks	Hickories	Gums	All others	Culls [2]	Total	All oaks	Hickories
Young stock:	*Cu. ft.*	*Cu. ft.*	*Cu. ft.*	*Cu. ft.*	*Cu. ft.*	*Cu. ft.*	*Bd. ft.*	*Bd. ft.*
2 inches	6.0	0.6	1.12	1.26	4.74	8.98		
4 inches	36.0	3.96	6.09	4.32	14.79	50.37		
Total	42.0	4.56	7.21	5.58	19.53	59.35		
Small timber:								
6 inches	30.00	5.20	9.0	16.83	18.16	61.03		
8 inches	40.81	3.08	8.25	34.80	31.52	86.94		
10 inches	42.70	2.44	7.43	56.24	37.26	108.81		
12 inches	31.68	2.88	12.60	52.92	51.84	100.08	88	8
Total	145.19	13.60	37.28	160.79	138.78	356.86	88	8
Medium timber:								
14 inches	62.10	2.70	18.90	50.92	80.99	134.62	161	7
16 inches	74.75	3.25	15.60	34.12	65.98	127.72	230	10
18 inches	74.16		15.90	14.58	46.42	104.64	252	
20 inches	34.90	2.68	6.90	13.42	24.16	57.90	136	10
Total	245.91	8.63	57.30	113.04	217.55	424.88	779	27
Large timber:								
22 inches	33.60	6.11	30.45	14.11	22.76	84.27	143	26
24 inches	7.70			14.16	28.54	21.86	34	
26 inches	15.21		21.00		20.76	36.21	63	
28 inches	4.91		5.22	1.74	2.56	11.87	19	
32 inches	10.00		15.00	3.33	8.80	28.33	36	
Total	71.42	6.11	71.67	33.34	83.42	182.54	295	26
Total for average acre	504.52	32.90	173.46	312.75	459.28	1,023.63	1,162	61

TABLE 17.—*Number of trees, volume, and growth in typical stand second-growth, river bottom hardwoods in lower Mississippi Valley*—Continued

Tree diameters at breast height	Saw timber volume—Continued			Average annual growth of saw timber [1]				
	Gums	All others	Total	All oaks	Hickories	Gums	All others	Total
	Bd. ft.	*Bd. ft.*	*Bd. ft.*	*Bd. ft.*	*Bd. ft.*	*Bd. ft.*	*Bd. ft.*	*Bd. ft.*
Small timber:								
12 inches	35	147	278	9.43	0.50	1.56	4.46	15.95
Medium timber:								
14 inches	49	132	349	8.62	.25	3.18	8.25	20.30
16 inches	48	105	393	11.50	.31	2.17	5.00	18.98
18 inches	54	50	356	15.75	------	2.45	1.50	19.70
20 inches	27	52	225	4.06	.19	.90	1.46	6.61
Total	178	339	1,323	39.93	.75	8.70	16.21	65.59
Large timber:								
22 inches	130	60	359	5.50	.62	3.82	1.25	11.19
24 inches	------	62	96	.89	------	--------	.77	1.66
26 inches	87	------	150	1.00	------	1.25	--------	2.25
28 inches	20	7	46	.27	------	.28	.05	.60
32 inches	54	12	102	.40	------	.55	.07	1.02
Total	291	141	753	8.06	.62	5.90	2.14	16.72
Total for average acre	504	627	2,354	57.42	1.87	16.16	22.81	98.26

[1] Only growth on sound trees has been calculated, but loss from mortality has not been deducted.
[2] Defective and suppressed trees not included in total effective growing stock.

Because of past cutting and considerable burning these stands include a volume of defective material sufficient to displace at least one third of the production that could be obtained if the growing stock were all of vigorous and well-formed trees. The problem of removing this material is difficult. Some of it, although unadapted to lumber use, can be cut into small-dimension material for furniture manufacture, stave bolts, railroad ties, or other uses. It may prove possible to remove from the stand by girdling large defective trees having no prospective value.

DETERMINATION OF GUIDING DIAMETER LIMITS FOR CUTTING

In the division of this section entitled, "Application of the Selective Cutting System," general principles on which trees should be selected for cutting were discussed in some detail. Some of the data used were drawn from the South. Figure 17, which bears on this subject as related to southern pines, is inserted here to show the relationship between cubic volume and board measure for trees of different sizes. It shows that trees 15 inches or more in diameter at breast height average about 185 cubic feet per 1,000 board feet. Trees from 8 to 14 inches in diameter contain about 250 cubic feet per 1,000 board feet. Disadvantages of producing lumber from southern pines less than 16 inches in diameter are as follows:

1. As much as 60 percent more volume must be grown to produce 1,000 board feet.

2. All this extra weight is expensive to handle. Partly for this reason, logging and milling costs are higher for these sizes.

3. To cut trees when they are small is to destroy them at just the time when they are beginning to yield their highest returns from growth, in volume and in quality. (See also pages 33–41.)

4. The lumber produced from the small sizes is much lower in grade and brings a lower price.

APPLYING SELECTION PRINCIPLIES IN THE MANAGEMENT OF SOUTHERN FOREST PROPERTIES

Since in the South extraction of timber is so simple and is carried on with such modest equipment, in that region it is wholly feasible to

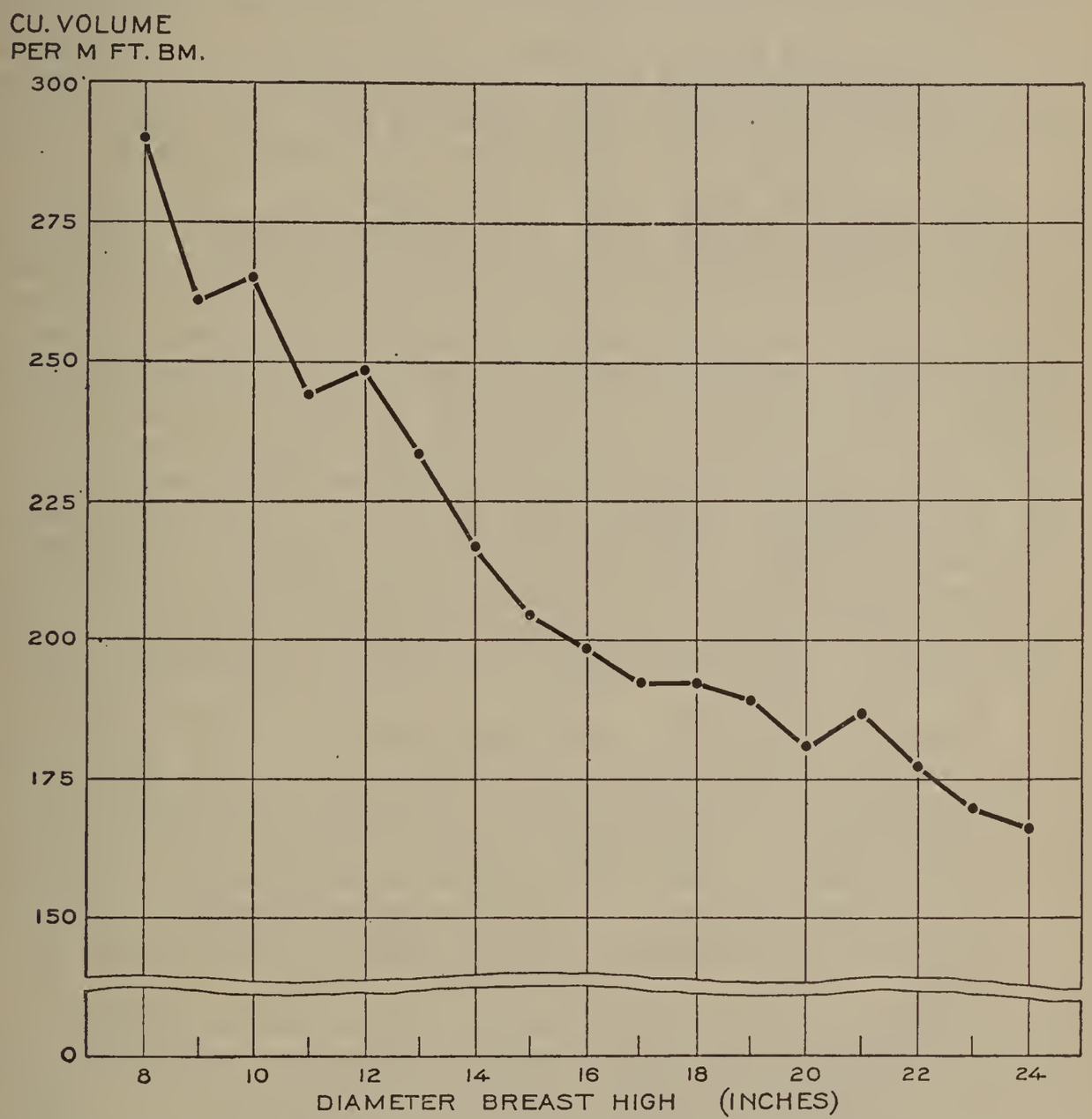

FIGURE 17.—Number of cubic feet tree volume (to 5-inch top) per thousand board feet—mill tally, southern pines.

operate forest properties of very small size as well as those up to 100,000 acres or more.

In the case of farm woodlands, experience has shown that selling the output on the stump seldom results in satisfactory prices. The best practice is for the farmer to sell his forest products in harvested form, as he sells his agricultural products. The same equipment, such as motor truck and teams, that is used in handling field crops can be devoted outside the crop season to getting out logs, pulpwood, etc. A well-stocked 100-acre farm woodland may yield as much as 50,000

board feet of logs annually. This can be gotten out in a month's time or less, and if sold as logs may bring as much as $500.

The Bureau of the Census now recognizes "forest-products farms" statistically. Ordinarily such a farm produces vegetables, milk, and other food supplies for the owner, but the owner's cash income derives chiefly from the sale of forest products. If the owner is to make good use of his time throughout the year on his own property and on a basis of permanence he must assemble an area of 1,000 acres or somewhat more, of which he can cut over about 100 acres annually for logs and cordwood. This is assuming that trees over 17 inches in diameter are cut for saw logs and the tops cleaned up for pulpwood or other cordwood material. In addition smaller trees of poor form for further growth, or needing to be removed from too dense stands, will go into cordwood. If the enterprise is to have permanence and constantly improving income the owner must strive to leave each unit of the forest in better condition for growth after each cutting period.

The same principle holds with larger properties. The Southern Forest Experiment Station (*27*), in studying selective cutting in second-growth stands, has found that in mixed short-leaf-loblolly pine with hardwoods cut to a 17-inch diameter limit 4,836 board feet per acre of logs from trees over 17 inches can be produced in the 10 years following cutting. In this case study taxes, fire protection, and administrative costs involved in producing stumpage on this basis amounted to 18 cents per acre per year or $1.80 for 10 years, or 37 cents per 1,000 board feet. On the basis of 1929 selling prices the gross returns from stumpage utilized were $5.26 and net earnings were $5.08 per acre per year. From this is derived the profits on milling and logging operations as well as on the forest investment. The investment was $25 per acre, so that the investment earnings averaged 20.3 per cent net. The area studied is, no doubt, exceptionally favorable.

If the diameter limit on the same area is reduced to 13 inches the growing stock left will produce only 3,508 board feet per acre in 10 years. Cutting to a 13-inch limit also will yield less stumpage value than in the above case. The returns will be reduced to $2.35 per acre gross and $1.64 per acre net with a 10 year cutting cycle. Unfortunately the common practice is to cut far under 13 inches and practically destroy the productivity of the average forest for some time after cutting.

By surveying a tract of virgin timber by the same procedure the station found that if a 21-inch diameter limit were established an average of 4,000 board feet per acre could be produced in 10 years. The current cost of producing stumpage, returning for a cut every 10 years, would be 82 cents per 1,000 board feet. This larger stumpage is much more valuable and the net returns, on the basis of 1929 costs and sales prices, become $5.67 per acre. From this must be derived all profits on the entire operation. The investment in this case is $35 per acre.

The low production costs in these three examples are the result of moderate taxes and low costs of fire protection and administration, combined with rapid growth, in stands that have not been seriously depleted or overcapitalized. These low costs are immediately attainable only in stands already reasonably well stocked, a description that unfortunately fits only a rather low percentage of

the southern forests. Other stands must go through a period of rebuilding the growing stock before they will give equal results. There are large areas in condition to yield a smaller net return during the rebuilding process.

It is clear that in the South, now that cutting operations in old-growth forests are approaching their end, owners of second-growth stands are fully justified in applying conservative management methods, particularly in observing cutting diameter limits not under 16 inches and building up the growing stock. Stumpage can be produced under these methods at a cost less than the accumulated holding charges that have now piled up against virgin timber. To build up the growing stock requires a reasonable degree of fire protection.

Costs of production have not been thoroughly studied in most other regions, but from general information now available it is safe to conclude that very few can equal the low costs shown in these examples.

The following quotation from a file report of the Southern Forest Experiment Station describes effective methods of managing longleaf-slash pine stands primarily for naval stores production (*23*):

> By far the most prevalent forest condition is that involving a group-selection stand, that is to say, several ages and sizes of trees intermingled on every acre. In some places large areas of second growth are found that are approximately even aged and more or less of the same size. In the future these areas will become more important. In general, the owner setting out to get full production will assemble as nearly as possible approximately equal stocking of the different age classes, and will constantly endeavor as operations proceed, by planting, by purchases, and by management itself, to improve the normality of his forest. His operations will involve (1) thinning his overstocked stands of young growth, possibly in two operations, the first when the trees are about 2 inches in diameter breast high and the second after the part of the stand to be removed has been turpentined; (2) turpentining the stand under conservative methods as long as profitable; (3) cutting the worked-out trees and obtaining a new stand, either naturally or by planting. The average rotation on the sites that will be handled under full-production management will be from 45 to 60 years.
>
> Absolute control of fire is an essential to full production. This involves complete protection of areas being restocked, and may or may not involve the use of fire as a protective measure in stands that are established. Fire control will be more expensive than for other types in the South, and complete immunity from fire damage is not to be expected.
>
> In the following example the measures proposed and their sequence are set out, together with the cost and returns per acre.
>
> The basic forest data were obtained from surveys made in Bradford County, Fla. The stand table and rate of growth are both based upon the better classes of forest land, such as would be chosen for intensive management. The forest portrayed is an all-aged, group-selection stand of longleaf and slash pine in which, at the beginning, 59 percent of the stems are longleaf and 41 percent are slash pine. The ages run from 1 year to 50 years. The diameters at breast height range from less than 1 inch to 16 inches. The stand per acre, at the beginning of management, is 283 stems, distributed as follows:

	Number	Percent
Seedlings 2 inches or less in diameter	145	51.3
Saplings 4 to 8 inches, inclusive, in diameter	96	33.9
Turpentined trees 10 to 14 inches, inclusive, in diameter	40	14.1
Saw timber 16 inches or more in diameter	2	.7
	283	100.0

The rate of diameter growth assumed is .31 inch per annum, which was the rate found generally on the better sites throughout Bradford County. This is conservative, as no increase is made on account of the improved growth conditions to be expected under management.

The forest is managed on a 48-year rotation, with a turpentine cycle of 8 years. The forest stand is thinned at the beginning of each 8-year period; the young stuff, 3 inches and under in diameter, standing as it does in thick clumps scattered over the area in the openings left by the removal, in previous operations, of the larger worked-out saw-timber trees, is thinned to an average stand of 80 trees per acre. At the beginning of management and in the eighth year this is the only thinning necessary, but in the sixteenth year and every eighth year thereafter the 8- and 9-inch trees, in addition, are thinned to 25 trees per acre. Before the trees to be removed are cut, they are worked for turpentine for 8 years. At the beginning of each 8-year cycle, the trees that have reached 9 inches diameter breast high are worked for turpentine under a conservative long-time method by which only one face is worked at a time. The first face is worked 7 years at the rate of 12 inches in height per season, after a rest period of a year the second face is started and carried for 7 years, there is another rest of one year, and the final face is placed and worked for 7 years. Then the tree is felled for saw timber. The opening resulting from the felling will restock naturally to slash pine seedlings. The first thinning, when the trees are between 6 and 12 years of age, costs 50 cents per acre, with no income; the thinning after turpentining in the 8-inch class pays for itself through the production of one cord of pulpwood per acre. The final cut is expressed in board feet, Doyle scale, with full deduction for cull caused by turpentining.

Fire protection is intensive, involving lookout towers, firebreaks, and organized personnel with equipment. It is assumed to be adequate to the extent of keeping at least 97 percent of the area free from uncontrolled fires, except for one serious conflagration such as may be expected in the pine belt on an average of once in 50 years. Losses due to this fire are included in the calculations of yield as running on from the middle of the rotation. Normal mortality throughout the rotation has been taken into account, in addition. Costs and returns for a 100,000 acre unit are shown below:

Average costs per acre per year:	
Protection and supervision	$0. 14
Taxes	. 20
Thinnings (every 8 years, at 50 cents)	. 06
Total	. 40
Average returns per acre per year:	
Naval stores rental from trees cut in thinning—2 cents per cup	. 41
Naval stores rental from trees of place, 4 cents per cup until trees become uniformly well spaced, then 5 cents per cup	2. 54
Saw-timber stumpage	. 48
Total	3. 43
Net annual returns per acre (average over a period of 48 years)	3. 03

The management outline given here is applicable to perhaps as much as 2 million acres of the better forest lands in the longleaf-slash pine type in north Florida and southeast Georgia, and elsewhere in the belt where forest conditions are similar

In bottom-land hardwoods the chief management problem, due in considerable degree to careless management in the past, is how to eliminate the large percentage of defective growing stock. There is an opportunity also to improve the composition of the stand. These measures can be put into effect only gradually, as outlets are found for the lower-grade material.

It is believed that even this partial consideration of facts bearing on private forestry in the South fully warrants the conclusion that the time has arrived to apply organized management to the forests still in condition to provide adequate yields. These facts definitely show that without aid nature cannot continue to provide the great volumes of forest raw material which have supported much southern labor and provided an investment field for much capital during the past half century.

HARDWOOD FORESTS OF THE CENTRAL STATES

(Ohio, Indiana, Illinois, Iowa, Missouri, Kentucky, Tennessee, and West Virginia)

PRESENT CONDITIONS AND MANAGEMENT POLICIES

The Central States are primarily a hardwood region, although at the higher altitudes certain conifers appear in mixture with hardwood species. The States of the Ohio Valley in particular were originally clothed with magnificent forests of valuable hardwoods such as oak, black walnut, yellow poplar, and ash. As a large part of the land that was occupied by these forests is valuable for agriculture, much of the area was cleared by early settlers for that purpose.

At the present time it is estimated that the region has 63,477,000 acres of privately owned forest including 5,110,000 acres rated as poor to nonrestocking, 12,078,000 acres rated as fair to satisfactory stocking, 25,368,000 acres of cordwood areas, and only 20,921,000 acres of saw-timber areas. There are 32,158,000 acres of farm woodland and 31,319,000 acres in other types of private ownership. (See table 1.)

EXTENT TO WHICH FORESTRY IS BEING PRACTICED

In the Central States there are three classes of private owners having somewhat different interests in their forest properties, with the consequence that their reasons for practicing forestry differ to a considerable degree. First, there is the farm-woodland owner, whose forest holdings are so intimately associated with farm operations that they can not readily be segregated from farm areas. This class of holding will be discussed later. Second, there is a large class of owners who are not farmers but who have other reasons for holding land than timber production. In this region mining (principally coal) is an important industry. Areas owned as mining property within the region are estimated as follows (*28*):

	Acres		*Acres*
Ohio	500, 000	Missouri	650, 000
Indiana	450, 000		
Illinois	700, 000	Total	2, 300, 000
Iowa	(1)		

A small number of owners of mining property have realized that their surface areas may as well be producing returns and have consequently initiated improved forestry practices. An added reason for the practice of forestry by these owners is that large quantities of mining timbers and other forest products are required in their own operations. Unfortunately the area on which improved forestry practice has been put into effect as a result of these considerations is not large.

The third class of forest owners are those holding timberland for the major purpose of obtaining saw logs or other forest products from the land. This category includes a number of pulp companies and sawmill owners as well as owners of a large acreage not connected with manufacturing enterprises. A small portion of the land owned by this class is being placed under continuous-yield management. Prevailingly, however, when any of this land is cut over it is cut so

[1] No data.

closely that no production of any importance can be obtained again within 60 to 75 years. A large proportion of this class of forest owners are paying very little attention to the permanent productivity of their holdings. As a class they have failed to grasp the principle that through a practice of light cuttings at any one time far higher-grade logs or other products can be obtained and that the trees remaining will lay on rapid growth and within 10 to 20 years provide another cut of equal amount.

The following statement summarizes reports by the Central States Forest Experiment Station as to the extent to which owners of the second and third classes are placing forest lands under management (*28*):

1. Independent or cooperative fire protection. Reports on this phase, somewhat incomplete, show 4,671,000 acres on which private owners participate in protective effort. State efforts add materially to this total.

2. Conservative cutting, planting, and other practices aimed at prolonging productivity of the forest. Reports show 1,560,000 acres on which some of these practices, principally selective cutting, are carried on.

3. Permanent ownership and organized sustained yield. Reports show 92,600 acres under this type of management. Some additional areas fall very little short of this classification.

It is apparent that only a relatively small proportion of the 31,319,-000 acres of privately owned forest lands other than farm woodlands is under any definite mangement looking to permanent productivity. The reason assigned by local observers for this condition is that past cutting operatings have reduced growing stock to such a point that further yields will be too long deferred to interest private owners.

PRODUCTION AND CONSUMPTION OF FOREST PRODUCTS

Industrial and domestic use of timber began in the Central States at the same time when early settlers began destroying large quantites of timber in order to clear the land for agriculture. In the course of time an important manufacturing industry developed, devoted especially to manufacturing lumber, furniture, and other products from the hardwoods. In the agricultural portions of the region there has been a large decline in the number of mills and the volume of output. Many of the remaining mills have had to ship in raw materials from the rougher portions of this region and from the bottom-land hardwood lands of the Mississippi Valley. Mills throughout the region continue to draw to a considerable extent, however, on local sources of log supply, especially farm woodlands. Ninety percent of the log supply of mills in the Corn Belt is said to come from farm woodlands.

Table 18, based on census figures and Forest Service data, shows the production and consumption of lumber in these States. These statistics indicate a deficit of 6,568,987 thousand board feet in regional lumber production as compared with use of lumber. The greater part of the deficit is in softwoods, which do not grow in much of the region.

Large quantities of other forest products are produced and consumed in the region, including posts, poles, fuel wood, pulpwood, etc., but

parallel statistics of production and consumption of these products are not easily available. This diversity of use has been pointed out as one of the leading elements facilitating complete utilization of saw-timber trees and the making of thinnings to improve younger stands. In the farm-woodland areas utilization is usually complete, owing to the diversity of wood uses on farms. More thought should be given to balanced use of the raw materials from the forests on other private lands.

TABLE 18.—*Lumber production and consumption in the Central States in 1928*

State	Lumber production [1]			Lumber consumption [2]
	Softwood	Hardwood	Total	
	M ft.b.m.	*M ft.b.m.*	*M ft.b.m.*	*M ft.b.m.*
Ohio	120	112, 109	112, 229	1, 522, 208
Indiana	21	126, 769	126, 790	837, 294
Illinois	484	29, 139	29, 623	2, 343, 258
Iowa [3]		13, 908	13, 908	980, 807
Nebraska				310, 690
Missouri	35, 272	106, 718	141, 990	762, 399
Kentucky	17, 050	157, 290	174, 340	451, 826
Tennessee	85, 592	444, 714	530, 306	802, 133
West Virginia	110, 383	437, 440	547, 823	235, 381
Total	248, 922	1, 428, 087	1, 677, 009	8, 245, 996

[1] Data from Forest Products, 1928: lumber, lath, and shingles. Bureau of the Census, 1930.
[2] Figures based on compiled data in the files of the Forest Service.
[3] Includes Kansas.

GROWING STOCK CONDITIONS

No stand tables are available for any of the hardwood forests which constitute the principal type of this region. The general condition of the stocking has been adequately described by State foresters and by members of the staff of the Central States Forest Experiment Station. These observers agree that the growing stock has seriously deteriorated in virtually all the hardwood forests. Conditions are considered especially serious in the farm woodlands, owing to grazing in addition to careless cutting. Farm-woodland deterioration is said to be more serious through the Corn Belt, where livestock is a very important factor in farm operation and where in consequence grazing use of woodlands is widespread.

MANAGEMENT OF FARM WOODLANDS

Authorities agree that if any woodland is to be preserved on the farm it should be segregated from the grazing areas. It is said that in the more hilly or mountainous parts of the Central States Region, including large portions of Kentucky, Tennessee, and West Virginia, increasing attention is being given to the management of farm woodlands as a major source of farm income.

Some excellent examples of management occur even on areas of less rough topography. A number of instances of this sort are cited in Farmers' Bulletin No. 1680 (*29*). Results obtained in certain Ohio communities which offer about the best examples of good farm-woodland management to be found in the region are described as

follows by Mr. Ralph K. Day, of the Central States Forest Experiment Station (*28*):

> Probably the outstanding examples of what can be done in the way of profitable woodland management are to be found among the Mennonite and Amish communities of Ohio and Indiana. These thrifty people have for generations utilized the otherwise slack winter months for woods work. In this manner they keep themselves and their teams profitably employed the year round. One owner who has kept an accurate record of all cash sales from his woodland, has permitted an analysis of his timber operations since the war. During the 13 years from 1919 to 1931, inclusive, he has received in cash a total of $10,457.73 for the forest products cut from 75 acres of farm woodland. This represents a gross return of $10.73 per acre per year. The entire area is classified under the Indiana forest tax law, and the annual taxes probably do not exceed 10 cents per acre. Since no outside labor was employed and the work was done at times when the men and teams would otherwise have been idle, the per acre return compares very favorably with the gross return of less than $19 per acre for all cereals grown in Indiana in 1929. During the 13 years for which records are available this owner has cut, sold, and delivered 266 thousand board feet of hardwood logs at an average price of $35 per thousand board feet. In addition, he has sold and delivered 643 cords of fuel wood at an average price of $3.10 per cord and supplied his own needs for fuel wood to the extent of approximately 25 cords per year. This does not include an unestimated amount of fence post material and other timbers cut and used on the farm. Although over 700 board feet per acre have been cut during the last 2 years, the farm woods appeared to be at least 90 percent stocked at the time of examination. An analysis of the annual returns of 10 other Indiana classified woodlands has been made by T. E. Shaw, extension forester of Indiana. This analysis reveals net profits ranging from $1.10 to $6.25 per acre per year and disregards the intangible values in fuel, fence posts, and rough timbers cut and used on the farms.

Current depression conditions emphasize the fact that farmers are generally overlooking their woodlands as a source of annual income. The foregoing quotation also emphasizes the desirability of farmers marketing timber in the form of logs or other material ready for manufacture. It is a general experience that farm-woodland timber sold on the stump brings only a small fraction of its actual value. Even more serious is the destruction wrought by portable mills on such tracts. The timber is invariably cut below merchantable size and future returns thereby deferred for a generation or more.

MEASURES NECESSARY TO IMPROVE FORESTRY PRACTICES

It is obvious that private ownership will continue to be of great importance in this region. One measure that can help in improving forest productivity is equitable assessment and collection of taxes, which is discussed elsewhere in this report. Another such measure is promotion of the public attitude which favors precautions against forest fire, trespass, and other public injuries. In addition it is necessary, where large continuous areas of woodland are involved, to build up definite organizations for the purpose of fire protection. These subjects are discussed elsewhere in this report.

A third measure, which is indispensable in promoting better use of the forest area, consists in putting into the hands of forest owners the necessary information regarding the proper care of their properties. This involves three steps: First, research, which is discussed elsewhere in this report; second, the establishment of demonstration areas and community projects; and third, extension work. By extension work throughout the region State foresters and extension foresters have already brought about considerable improvement in management practices. These efforts need further support. In order to obtain

more information and to set up definite demonstrations extra activity is justified in localities where manufacturing plants provide a balanced demand for forest products. Effort should be directed toward still further improvement of manufactured products through production engineering, and toward modification of raw-material purchasing methods to permit the best use of forest productivity. Cooperation of manufacturers with forest owners would enable the latter to build up growing stock and forest productivity through marketing forest raw material of the kinds that it is most desirable to remove.

FORESTS OF THE LAKE STATES REGION

(Michigan, Wisconsin, Minnesota, and North Dakota)

PRESENT CONDITIONS AND MANAGEMENT POLICIES

The Lake States were formerly a very important conifer region, of which the most characteristic type was the northern white pine forest. (North Dakota, which is here thrown in this group for statistical purposes, has very little forest area). Early settlement did not lag far behind that in the Central States, and the same practice of destroying timber to clear land was in effect for some time. The use of timber in industry was soon under way. Commercial production of forest materials started first in the agricultural settlements in the southern part of the region and was later extended into the forest areas to the north. The white pine forests, as the most valuable, were the scene of the earliest operations on a large scale. Commercial production of northern white pine had begun to expand by the end of the Civil War, and approached a maximum by 1882. At one time the annual regional cut of northern white pine rose to nearly 9 billion feet. Decline in production of white pine had set in by 1895 and has been more or less continuous down to the present day. The northern white pine type has now been almost entirely destroyed, and with the exception of some spruce and Norway pine the remaining conifers are of relatively inferior character. The coniferous forest has to a very large extent been superseded by inferior broad-leafed species, of which scrub oak and aspen are the most plentiful. In addition to the area now or formerly occupied by coniferous forests there is a considerable area of northern hardwoods (yellow birch, sugar maple, and beech) with hemlock. These northern hardwood and hemlock forests are the location of the principal remaining forest industry.

By the time the white pine industry had begun to decline the pulp and paper industry had begun to attain importance in the region. Large plants are located in Wisconsin, Minnesota, and Michigan. These plants are able to use trees of species and sizes that as a rule are of small value in the lumber industry. This provides conditions for balanced production in continuously operated forest properties; revenue from the sale of cordwood material to the pulp and paper mills helps the landowners to meet production expenses and lowers the cost of producing the more valuable saw-log material. Unfortunately the stands have already deteriorated too far to provide the saw-timber constituents of the cut on a current basis. It appears, therefore, that the pulp and paper industry will have to rely largely on forests operated, for the present at least, mostly for the production of pulpwood. This means special capital investments in forests for

this purpose, which is a rather severe handicap in comparison with the conditions in regions where saw timber furnishes sufficient returns to support forest investments and pulpwood is more or less of a by-product furnishing an added return. By saving portions of the stand at each cutting for further development, it is possible to rebuild stands to saw-timber production.

Table 1 credits the region with 49,073,000 acres of privately owned forests, of which 14,281,000 acres is farm woodland. As to general condition the forest land is classified as follows: Poor and nonrestocking, 12,133,000 acres; fair to satisfactory restocking, 24,683,000; cordwood, 7,833,000 acres; and saw timber, only 4,424,000 acres. It is clear that liquidation of the forest capital has proceeded farther than in any other major forest region. Local observers do not report very much evidence that this process has discontinued, and it seems probable that it will continue until the original forest area is reduced to a minimum. The final steps in this process will leave a huge area of very low-grade stands. Table 19 shows in some detail the present situation in forests other than farm woodlands.

TABLE 19.—*Commercial forest in private ownership in the Lake States in 1932* [1]

State	Areas [2] (thousand acres)	Ratio to total commercial forest area (percent)	Condition classes					
			Merchantable				Nonmerchantable	
			Saw timber		Cordwood		Restocking	Not restocking
			Thousand acres	Million board feet	Thousand acres	Thousand cords	Thousand acres	Thousand acres
Michigan	12,947	68	1,209	12,928	1,363	61,179	8,329	2,046
Minnesota	12,178	60	487	3,096	548	17,354	8,895	2,248
Wisconsin	9,617	59	932	6,343	1,267	38,010	6,170	1,248
Total	34,742	63	2,628	22,367	3,178	116,543	23,394	5,542

[1] Data from Forest Statistics for the Lake States, 1931, compiled by the Lake States Forest Experiment Station. Revised Mar. 30, 1932.
[2] Exclusive of farm woodlands.

PRODUCTION AND CONSUMPTION OF FOREST MATERIALS, AND STATUS OF LUMBER AND PAPER INDUSTRIES

Lumber production in the Lake States region is now relatively unimportant as compared with the great production of former years. The deficit in lumber production as compared with consumption in 1928 was 1,808,871,000 board feet. Table 20, based on census data, shows the production and consumption of lumber in these States in 1928, the latest year for which both production and consumption figures are available.

TABLE 20.—*Lumber production and consumption in the Lake States in 1928*

State	Lumber production [1]			Lumber consumption [2]
	Softwood	Hardwood	Total	
	M feet board measure	*M feet board measure*	*M feet board measure*	*M feet board measure*
Michigan	141, 787	430, 272	572, 059	1, 714, 462
Wisconsin	352, 548	466, 302	818, 850	1, 030, 501
Minnesota	359, 618	52, 725	412, 343	725, 825
North Dakota	----------	----------	----------	141, 335
Total	853, 953	949, 299	1, 803, 252	3, 612, 123

[1] Data from Forest Products, 1928: Lumber, Lath and Shingles. Bureau of the Census, 1930.
[2] Figures based on compiled data in the files of the Forest Service.

Table 21 (*30*) shows the statistical position of the lumber and paper industries in the region in 1929. The value of the paper-industry products was rated as more than twice that of the products of the lumber industry.

TABLE 21.—*Statistical position of lumber, pulpwood, and paper industries, Lake States, 1929* [1]

State	Lumber industries				
	Number of establishments	Salaried men and average number of wage earners	Salaries and wages	Value of products	Quantity of lumber produced
			Thousands of dollars	*Thousands of dollars*	*M board feet*
Michigan	294	17, 554	23, 701	68, 885	571, 017
Minnesota	191	8, 066	10, 174	30, 839	357, 180
Wisconsin	346	24, 514	28, 604	82, 369	842, 814
Total	831	50, 134	62, 479	182, 093	1, 771, 011

State	Pulp and paper industries				
	Number of establishments	Salaried men and average number of wage earners	Salaries and wages	Value of products	Quantity of pulpwood produced
			Thousands of dollars	*Thousands of dollars*	*Cords*
Michigan	53	13, 572	21, 717	106, 004	313, 477
Minnesota	13	2, 811	4, 146	28, 317	266, 320
Wisconsin	79	14, 513	20, 765	129, 459	1, 233, 962
Total	145	30, 896	46, 628	263, 780	1, 813, 759

[1] Census of Manufactures, 1929, Industry Series.

EXTENT TO WHICH PRIVATE FORESTRY IS BEING PRACTICED

In the Lake States, as in the Central States, three classes of owners are to be considered. The first class, the farm-woodland owners, have problems very similar to those in the Central States. The

second class, those who are not farmers but nevertheless have other reasons for holding forest land than the production of timber, are probably less numerous than in the Central States since the mineral area is less in this region. This class is augmented to some extent by those holding land for recreational purposes.

The third class, those holding timberland primarily for the purpose of producing forest products, hold nearly all the commercial forest lands in the region other than farm woodlands. This class is generally characterized by uniting manufacturing enterprises with timber holding. The union of these two types of enterprises seems to encourage hasty liquidation of the forests rather than to retard it. The large capital investment in the manufacturing enterprise generally results in a desire to operate continuously to keep the capital from being idle. Where these two distinct forms of capital investment are kept separate, there is not nearly so much pressure toward operating. The mill owner, not having so many taxes and other fixed overhead charges to meet, is in a position to restrict his operations to periods when some profit can be obtained; and the forest owner soon learns by experience that it is good business to dispose of sufficient timber in times of active demand to create financial reserves sufficient to carry him through periods of low demand. The forest owner of necessity takes constant note of the movement of stumpage prices. This is greatest during periods of change from depression to prosperity; at those periods, therefore, accumulation of profit from holding stumpage is most rapid. Obviously, disposal of stumpage or saw logs at the low point of depression periods represents a large loss to be guarded against where possible by preparing in advance for these contingencies.

The following summary of reports by the Lake States Forest Experiment Station indicates the extent to which forest owners other than farmers are placing forest land under management.

1. Fire protection, independent or in cooperation with States. State-wide fire protection is furnished by public agencies in all these States. Lumber companies provide special fire protection for their logging operations and cooperate with the States in protecting their lands. The region has one forest-protective association. This association, in northern Minnesota, with State cooperation maintains organized protection on 125,000 acres of timberland.

2. Conservative cutting and other practices aimed at prolonging productivity of the present stand. It is estimated that all but 4 of the 34 remaining large mills will be cut out in the next 12 to 15 years. This means that a sustained-yield policy was not considered early enough. Selective logging, planting, and similar measures are practiced to some extent. The exact acreage is not reported, but 100,000 acres is mentioned as having been purchased by companies to build up production of pulpwood. One company is providing sufficient acreage to yield a second cut. Plantations totaling 28,000 acres had been established by 1930. No definite plans for sustained yield are reported.

From this summary it is clear that of the huge area of privately owned forest land very little is under any management looking to continued productivity.

GROWING-STOCK CONDITIONS

No detailed stand tables are at hand for any of the stands in this region. The general condition of the growing stock can be inferred from what has already been stated in describing the history of cutting operations. The areas formerly occupied by coniferous forests now have very poor stands of aspen and other inferior species. The growing stock in the remaining northern hardwood forests possesses considerable similarity to the growing stock in hardwood forests in the Middle Atlantic and New England States (see fig. 18), except that in the latter regions more or less cutting has been going on in most stands. In the Lake States the hardwood forests are in general being cut over for the first time, except that on some areas white pine intermingled with other species was removed long ago. Most observers agree that for this reason larger tree sizes are to be found and the product is perhaps somewhat higher in quality than that taken from the forests of the same species in the northeastern region.

FUTURE PROSPECTS FOR PRIVATE FORESTRY

Mr. Raphael Zon, who has given a great deal of thought to present and future forest conditions in the Lake States, predicts (*30*) that about 6 million acres in Michigan, Wisconsin, and Minnesota will eventually be put under rather intensive private forestry management. Mr. Zon estimates that only 14,200,000 acres of additional forest will be placed under intensive management in Federal, State, and county ownership within the near future. This will leave 39,600,000 acres in all classes of ownership under nonintensive management. According to this estimate, prospects for the reestablishment of large forest production in the region in the immediate future are not particularly good. It appears that the region, having a large resident population and being close to other great centers of population, will for some time constitute a large market for the forest products of other regions.

Most of the forest area in this region represents, from the forest-productive standpoint, an example of conditions discussed earlier in this section, wherein practically all the capital required for forest production has been removed. On huge areas not more than 1 to 5 percent of the necessary capital (inclusive of the value of the land) is present. To restore production on these areas will require not only heavy money investments but a considerable period of time. The region is confronted with a forest-reclamation project of great magnitude.

The forests of aspen and other inferior species are an example of impoverished resources such as Americans have not yet had to deal with on many areas. Where a resource has been brought into such a condition but a population remains to live from it, both labor and capital must operate on a reduced scale of income if at all until the resource is restored. On the other hand, owing to the near exhaustion of the forests in the Lake States, local forest industries are relieved of competition to the approximate extent of freight rates from the Pacific Northwest or to the South. It is essential both to the economic and to the social well-being of the region that large forest areas

within easy reach of transportation facilities of the Great Lakes or of centers of population be restored to productivity. This job will require public assistance through many if not all of the channels discussed elsewhere in this report. No single method will solve the problems involved.

FORESTS OF THE NEW ENGLAND AND MIDDLE ATLANTIC STATES

(Maine, New Hampshire, Vermont, Massachusetts, Connecticut, Rhode Island, New York, Pennsylvania, New Jersey, Delaware, and Maryland)

PRESENT CONDITIONS AND MANAGEMENT POLICIES

The New England and Middle Atlantic States include most of the centers of early settlement by British and Dutch colonists in North America. Since virtually all the land surface was covered with forests, it was necessary to destroy considerable forest growth in order to clear agricultural land. As in the case of other eastern forest regions, industrial use of the forest began at the time of settlement by whites and has continued down to the present day. Partly because of the mixed character of the stands, which included species of high, medium, and low value, the forest in much of these regions has never been devastated to the degree that has occu red in regions having forests of a few high-value species. The fact that the precipitation is well distributed is another large factor in preserving the forest growth. Owing to the early development of the industry, the devastation that did occur in such types as the white pine and hemlock culminated in the latter part of the nineteenth century. On the whole, the value of the forest stands shows considerable recovery from its extreme low point. The types in which cutting has been in progress for centuries, and the types that were clean cut and now have young stands reestablished, are to a considerable extent still in a deteriorated condition from the standpoint of the character of the growing stock present. This condition, together with the steps necessary to correct it, will be discussed later.

According to the best available estimates (table 1) these regions have 50,909,000 acres of privately owned forests, including 15,863,000 acres of farm woodlands. Of this total, 5,286,000 acres is rated as poor to nonrestocking, 10,923,000 acres as fair to satisfactory restocking, 14,239,000 acres as bearing cordwood stands, and 20,461,000 acres as bearing saw-timber stands. In addition to these areas now in forest, there are large areas of abandoned nonforested farm lands available for afforestation.

More detailed information is available for Pennsylvania than for the other States of these regions. Here large areas were cut over on a nonselective basis. This occurred principally in two types—the northern white pine-hemlock, which yielded sufficient values to encourage clear cutting, and the hardwood types, clear cut because of the demand for mine timbers and distillation wood, both of which can be obtained from small-sized trees. These clear-cutting operations, followed by repeated fires for many years, have resulted in considerable devastation. With the establishment of State fire protection in recent years the devastated area has diminished materially. The Pennsylvania Department of Forests and Waters within the last few years made a rather careful survey of the condition of the forest

areas of that State, which revealed 11,489,225 acres of large forest areas and 1,716,775 acres of areas not exceeding 50 acres completely or partially surrounded by cleared land. These small areas may be considered as composed entirely of farm woodlands. Considerable woodland owned by farmers is included within the large forest areas, also. The total forest area was classified as follows:

1. Lands burned until practically no forest growing stock remains (now occupied by bracken, huckleberries, briars, fire weeds, etc.), 300,668 acres.
2. Brush lands (now occupied by scrub oak, fire cherry, and aspen, occasionally with low sprouts of valuable tree species), 1,565,508 acres.
3. Young forest growth (valuable growth, up to a diameter of 6 inches, taking the lead over brush), 7,594,418 acres.
4. Merchantable timber (stands in which more than 50 percent of the trees are 6 inches or over in diameter), 3,745,407 acres.

Comparison of these data with reports of 15 to 20 years ago (*31*) seems to show that conditions have materially improved in recent years. It is reasonable to attribute this improvement to the substantial realization of objectives set up by foresters and public officials about 30 years ago, which, with support from the public, began to be realized during the last 20 years. These objectives centered largely around fire protection.

EXTENT TO WHICH PRIVATE FORESTRY IS BEING PRACTICED

These regions, also, have three classes of private forest owners. Ownership of forest land incidental to the holding of other resources is widespread; recreational use of land and control of water resources are more or less joined with forest ownership, and in Pennsylvania it is reported that 6,600,000 acres of forest land is owned in connection with mineral resources. To a considerable degree ownership of commercial timberlands is tied up with manufacturing enterprises, especially pulp and paper mills.

Many privately owned areas have been yielding forest crops at short intervals from the time of the earliest settlement. Until within the last quarter century this continuous yield, generally speaking, took place without much intent on the part of the forest owner. Originally it came about through the practice of first cutting from the forest only the high-grade species such as northern white pine. After a few years cutting would be undertaken on the same area for some other species that had become valuable. The openings made in the forest by this type of cutting became restocked with young trees. Some of the species, such as the northern hardwoods, spruce, and hemlock, were uneven aged to begin with. The natural form of the forest together with the system of partial cuttings resulted, over large areas, in forests of a rough selection form. Unfortunately, because of lack of effort to remove inferior trees and a general practice of taking the best species and best-formed trees the productive capacity is far below what it would be under a well-planned application of the selection system, which systematically eliminates poor and ineffective growing stock and builds up effective growing stock.

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Owing to the prevalence of public fire-protection activities, considerable growth is being produced on a great deal of forest land which without such public fire protection would continue in a very low state of productivity. Reports (*32*) as to areas being managed under one or another of three grades of forestry practice are summarized as follows:

1. Fire protection by States, independently or with the cooperation of landowners. On the basis of long experience in attempting to control forest fires, landowners in these regions have generally come to rely almost entirely upon public fire protection, to which the Federal Government contributes as provided by the Clarke-McNary law. Practically the entire forest area is protected. The basis of fire protection in these States is fully covered elsewhere in this report. Private owners assist in fire prevention and fire suppression with their own forces. In the Maine forest district a millage tax is levied for fire-protective purposes.

2. Conservative cutting, planting, thinnings (including insect-control thinnings), etc., aimed at prolonging the productivity of the present stands but not definitely organized for sustained yield. Forest areas to the extent of 5,497,300 acres, including farm woodlands, are reported to be held by owners consciously making efforts to prolong or build up the productivity of their holdings. There is no doubt that relative safety from fire, due to nearly adequate public fire protection, has made it possible for private owners to improve their forest practices and to feel financially secure in so doing. In addition to the area consciously subjected to improved management practices 3,583,000 acres of land is reported to be handled under partial-cutting systems.

3. Sustained-yield management. Reports (*32*) show 648,592 acres, not including farm woodlands, now organized under definite sustained-yield programs. As a whole, therefore, the progress in these regions is encouraging. Vast areas remain, however, to be brought under organized sustained-yield management.

PRODUCTION AND CONSUMPTION OF FOREST PRODUCTS

Since these regions contain the largest centers of population in the United States, they are very heavy consumers of forest products. Throughout a long period of their history they produced sufficient forest products for their own needs, with the exception of a few kinds of material not producible in the region. For more than half a century, however, they have been importing increasing quantities of forest products of all kinds, chiefly from other portions of the United States and from Canada. The shortage in local production has created a favorable market situation for most of the local forest raw material. The wood-manufacturing industries have in many cases suffered severely, however, from the inadequacy of supplies of suitable material. Over a long period of time the raw material of better species and grades has been approaching depletion. Consequently local industries have had either to make use of poorer raw material or import from a distance. The measures necessary to correct this situation are discussed later. Table 22 shows the production and consumption of lumber in each of these States and in the regions as a whole in 1928.

TABLE 22.—*Lumber production and consumption in the New England and Middle Atlantic States in 1928*

State	Lumber production [1]			Lumber consumption [2]
	Softwood	Hardwood	Total	
	M ft.b.m.	*M ft.b.m.*	*M ft.b.m.*	*M ft.b.m.*
Maine	240, 569	25, 954	266, 523	262, 259
New Hampshire	211, 190	28, 071	239, 261	225, 873
Vermont	53, 527	53, 831	107, 358	116, 725
Massachusetts	78, 585	33, 714	112, 299	908, 057
Connecticut	9, 878	25, 478	35, 356	300, 083
Rhode Island	1, 815	2, 807	4, 622	160, 299
New York	32, 166	97, 940	130, 106	3, 088, 022
Pennsylvania	84, 185	154, 430	238, 615	1, 760, 030
New Jersey	102	3, 118	3, 220	834, 643
Delaware	10, 926	2, 235	13, 161	48, 137
District of Columbia				47, 471
Maryland	29, 533	30, 196	59, 729	511, 946
Total	752, 476	457, 774	1, 210, 250	8, 263, 545

[1] Data from Forest Products, 1928: Lumber, Lath, and Shingles. Bureau of the Census, 1930.
[2] Figures based on compiled data in the files of the Forest Service.

The deficit of lumber production shown is 7,053,295,000 board feet. In these regions the consumption of virtually every kind of forest product is very heavy. Pulp and paper are probably next in importance to lumber. For most forest products that can be produced in the regions, a market is available at no great distance.

GROWING-STOCK CONDITIONS

Stand tables are available for stands of five of the types which occur in these regions. It is not known over how much area these tables actually apply. Stand conditions are shown for four different localities as discussed in the following.

NORTHERN HARDWOODS IN THE WHITE MOUNTAINS AND IN THE ALLEGHENY MOUNTAINS (*32*)

These stands are made up of similar species, with sugar maple, yellow birch, and beech as the most common. Growth rates are available only for the White Mountain stand. It is probable that the growth rates in the Allegheny Mountains differ to some extent owing to climatic factors. Stands of this type are common in the northern parts and at the higher altitudes farther south throughout the regions. Figure 18 shows the distribution of cubic volume in each stand and table 23 shows the details of conditions in the White Mountain stand. The stands are in need of management to remove inferior species and trees and build up a growing stock with a reasonable representation of larger diameter classes. The principal difficulty in the way of this procedure is the lack of market for the kind of materials such a cutting practice would yield. In many localities where a market for fuel or other small-size products exists, however, it is possible to carry out operations of this kind.

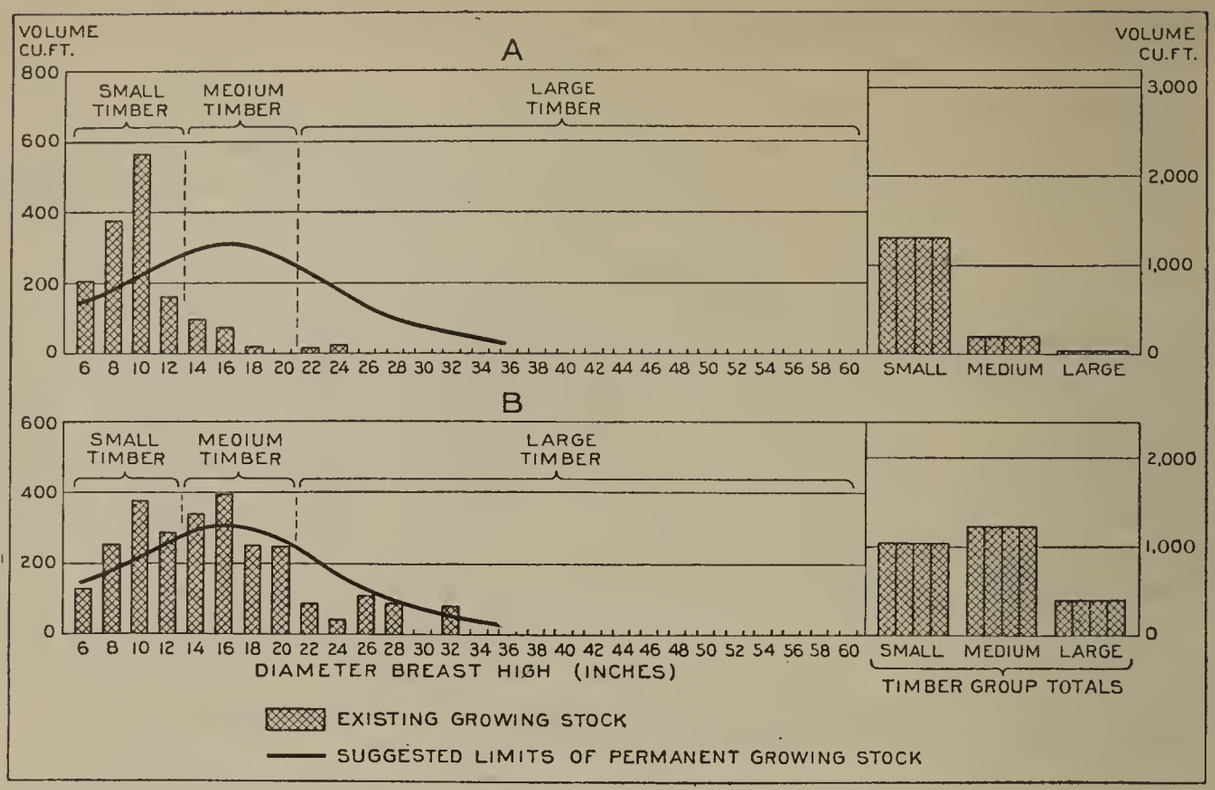

FIGURE 18.—Distribution of cubic volume by diameter classes on average acre, northern hardwood second-growth stands, with some timber left from previous stands. A, Stand in White Mountains. Thinnings from inferior species among the small timber would remove surplus from that group and hasten growth of released trees into larger groups; B, represents average of considerable areas in Pennsylvania. Distribution of size classes is better, but larger classes need building up.

TABLE 23.—*Number of trees, volume, and growth in all-aged northern hardwood stand in northern White Mountains, New Hampshire*

Tree diameters at breast height	Trees per average acre						Time required to grow to next diameter class	
	Red spruce and hemlock	Beech	Sugar maple	Yellow birch	Other hardwoods	Total stand	Conifers	Hardwoods
Young stock:	*Number*	*Number*	*Number*	*Number*	*Number*	*Number*	*Years*	*Years*
2 inches	37.50	90.75	22.50	10.75	9.75	171.25	71	59
4 inches	12.50	62.50	13.75	8.75	13.00	110.50	62	38
Total	50.00	153.25	36.25	19.50	22.75	281.75		
Small timber:								
6 inches	1.50	23.25	10.00	10.50	8.75	54.00	62	28
8 inches		17.75	7.00	9.25	6.25	40.25	59	22
10 inches	50	15.50	5.50	4.75	8.50	34.75	55	20
12 inches	50	1.25	2.50	1.50	1.25	7.00	53	20
Total	2.50	57.75	25.00	26.00	24.75	136.00		
Medium timber:								
14 inches	.25	1.50	.75		.25	2.75	50	21
16 inches	.25	.25	.50	.50	.25	1.75	48	22
18 inches		.25				.25		25
20 inches								29
Total	.50	2.00	1.25	.50	.50	4.75		
Large timber:								
22 inches					.25	.25		36
24 inches					.25	.25		50
Total					.50	.50		
Total for average acre	53.00	213.00	62.50	46.00	48.50	423.00		

TABLE 23.—*Number of trees, volume, and growth in all-aged northern hardwood stand in northern White Mountains, New Hampshire*—Continued

Tree diameters at breast height	Cubic volume						Saw-timber volume		
	Red spruce and hemlock	Beech	Sugar maple	Yellow birch	Other hardwoods	Total	Red spruce and hemlock	Beech	Sugar maple
	Cubic feet	*Cubic feet*	*Cubic feet*	*Cubic feet*	*Cubic feet*	*Cubic feet*	*Board feet*	*Board feet*	*Board feet*
Young stock:									
2 inches	3.75	27.22	2.25	2.15	2.34	37.71			
4 inches	7.50	112.50	6.88	5.25	20.80	152.93			
Total	11.25	139.72	9.13	7.40	23.14	190.64			
Small timber:									
6 inches	5.25	120.90	19.00	22.05	37.62	204.82			
8 inches		193.48	56.00	76.78	53.75	380.01		302	168
10 inches	6.70	288.30	82.50	70.30	124.95	572.75	25	775	270
12 inches	9.65	34.75	57.75	33.45	27.25	162.85	35	110	192
Total	21.60	637.43	215.25	202.58	243.57	1,320.43	60	1,187	630
Medium timber:									
14 inches	6.50	61.20	24.08		7.38	99.16	25	195	87
16 inches	9.70	14.22	21.30	21.40	9.75	76.37	40	46	78
18 inches		18.58				18.58		62	
Total	16.20	94.00	45.38	21.40	17.13	194.11	65	303	165
Large timber:									
22 inches					17.90	17.90			
24 inches					21.08	21.08			
Total					38.98	38.98			
Total for average acre	49.05	871.15	269.76	231.38	322.82	1,744.16	125	1,490	795

Tree diameters at breast height	Saw-timber volume—Continued			Average annual growth of saw timber [1]					
	Yellow birch	Other hardwoods	Total	Red spruce and hemlock	Beech	Sugar maple	Yellow birch	Other hardwoods	Total
	Board feet	*Board feet*	*Board feet*	*Board feet*	*Board feet*	*Board feet*	*Board feet*	*Board feet*	*Board feet*
Small timber:									
8 inches	194	150	814		26.6	8.0	13.0	6.8	54.4
10 inches	247	408	1,725	0.2	29.4	7.7	7.1	9.8	54.2
12 inches	123	89	549	0.3	2.6	4.9	2.5	1.9	12.2
Total	564	647	3,088	0.5	58.6	20.6	22.6	18.5	120.8
Medium timber:									
14 inches		26	333	0.3	3.9	1.4		0.4	6.0
16 inches	82	34	280	0.3	0.7	1.0	1.0	0.4	3.4
18 inches			62		0.8				0.8
Total	82	60	675	0.6	5.4	2.4	1.0	0.8	10.2
Large timber:									
22 inches		64	64					0.3	0.3
24 inches		75	75					0.2	0.2
Total		139	139					0.5	0.5
Total for average acre	646	846	3,902	1.1	64.0	23.0	23.6	19.8	131.5

[1] No information available on tree mortality and no deduction has been made for this factor. Net growth may not exceed 75 percent of the total growth shown. Growth on smaller trees cannot be computed in board feet.

SPRUCE FLAT TYPE

This is representative of spruce stands which occur on rather limited areas in Maine, New Hampshire, Vermont, and northern New York. For the past quarter century or more there has been a very active demand for spruce pulpwood throughout the spruce region. The tendency, therefore, has been to keep the spruce cut out

of the forest, to rather low diameter classes. There is some question at the present time as to whether a cutting procedure that will build up stock of higher diameter classes may not be desirable on account of the slackening in the demand for pulp sizes and on account of the

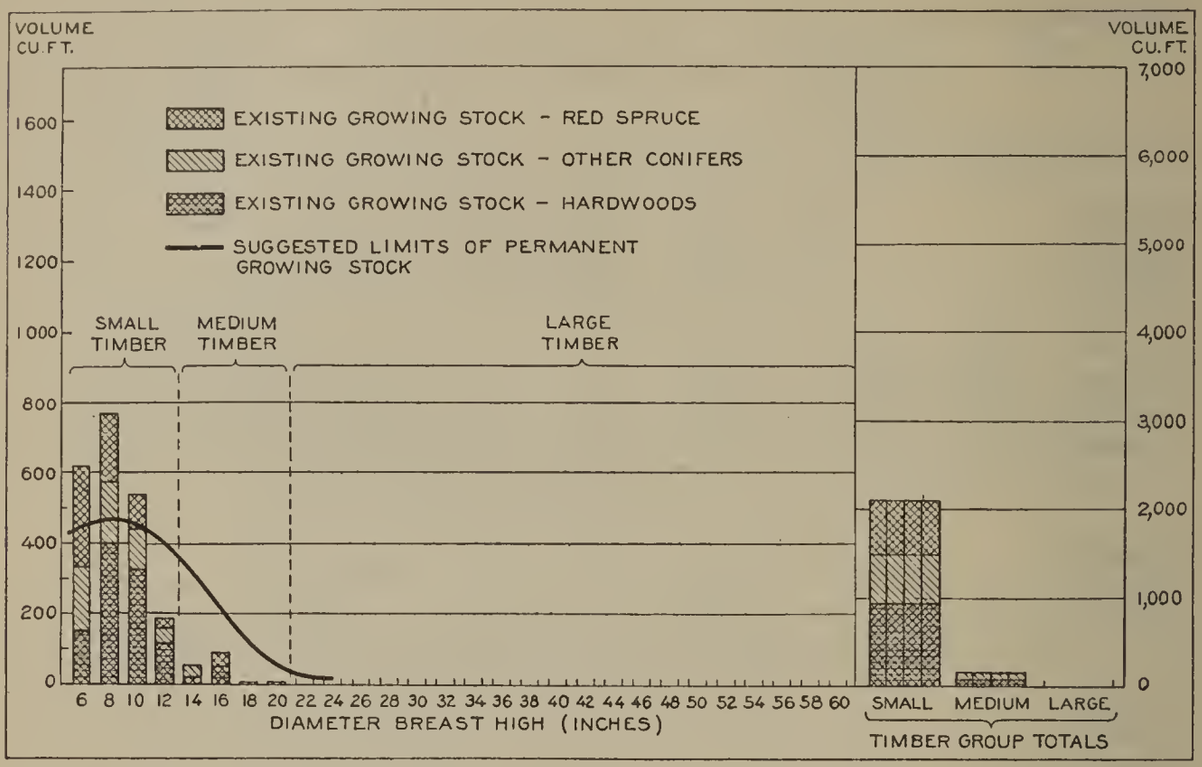

FIGURE 19.—Distribution of cubic volume by diameter classes on average acre, red spruce flat, White Mountains. Although most of the timber falls in the small timber group, it is probably not feasible to build up the larger diameter classes materially excepting the white pine and some of the associated hardwoods.

possibility of getting a better price for at least a portion of the material. Figure 19 and table 24 show details of growing-stock conditions in an example of this type.

TABLE 24.—*Number of trees, volume, and growth in red spruce flat type in White Mountains, N.H.*

Tree diameters at breast height	Trees per average acre			Number years required to grow to next diameter class		Cubic volume		
	Red spruce	Hardwoods	Total stand	Red spruce	Hardwoods	Red spruce	Hardwoods	Total
Young stock:	*Number*	*Number*	*Number*	*Years*	*Years*	*Cubic feet*	*Cubic feet*	*Cubic feet*
2 inches	141.26	111.18	252.44	71	59	14.13	22.23	36.36
4 inches	145.37	105.49	250.86	62	38	87.22	63.29	150.51
Total	286.63	216.67	503.30			101.35	85.52	186.87
Small timber:								
6 inches	82.23	73.65	155.88	62	28	287.80	154.66	442.46
8 inches	27.43	48.38	75.81	59	22	192.01	401.55	593.56
10 inches	6.97	22.26	29.23	55	20	93.40	329.45	422.85
12 inches	1.54	5.28	6.82	53	20	29.72	117.74	147.46
Total	118.17	149.57	267.74			602.93	1,003.40	1,606.33
Medium timber:								
14 inches	.11	.63	.74	50	21	2.86	20.16	23.02
16 inches	.17	.17	.34	48	22	6.60	72.76	79.36
18 inches	.06		.06	45		.29		.29
20 inches				43				
Total	.34	.80	1.14			9.75	92.92	102.67
Total for average acre	405.14	367.04	772.18			714.03	1,181.84	1,895.87

TABLE 24.—*Number of trees, volume, and growth in red spruce flat type in White Mountains, N.H.*—Continued

Tree diameters at breast height	Saw-timber volume			Average annual growth of saw timber [1]		
	Red spruce	Hard-woods	Total	Red spruce	Hard-woods	Total
Small timber:	*Board feet*	*Board feet*	*Board feet*	*Board feet*	*Board feet*	*Board feet*
8 inches	549	1,016	1,565	13.9	68.2	82.1
10 inches	348	1,158	1,506	2.5	33.4	35.9
12 inches	108	433	541	.9	8.7	9.6
Total	1,005	2,607	3,612	17.3	110.3	127.6
Medium timber:						
14 inches	11	72	83	.1	1.5	1.6
16 inches	27	28	55	.2	.4	.6
18 inches	13	----------	13	.1	----------	.1
Total	51	100	151	.4	1.9	2.3
Total for average acre	1,056	2,707	3,763	17.7	112.2	129.9

[1] No deduction has been made for tree mortality, losses from wood-rotting fungi, etc. Net growth may not exceed 75 percent of the total growth shown. Growth on smaller trees not computed in board feet.

OAK-HARDWOOD TYPES IN CONNECTICUT

The two stands represented in figures 20 and 21 have been under good management for over 25 years. Two or three cuttings have

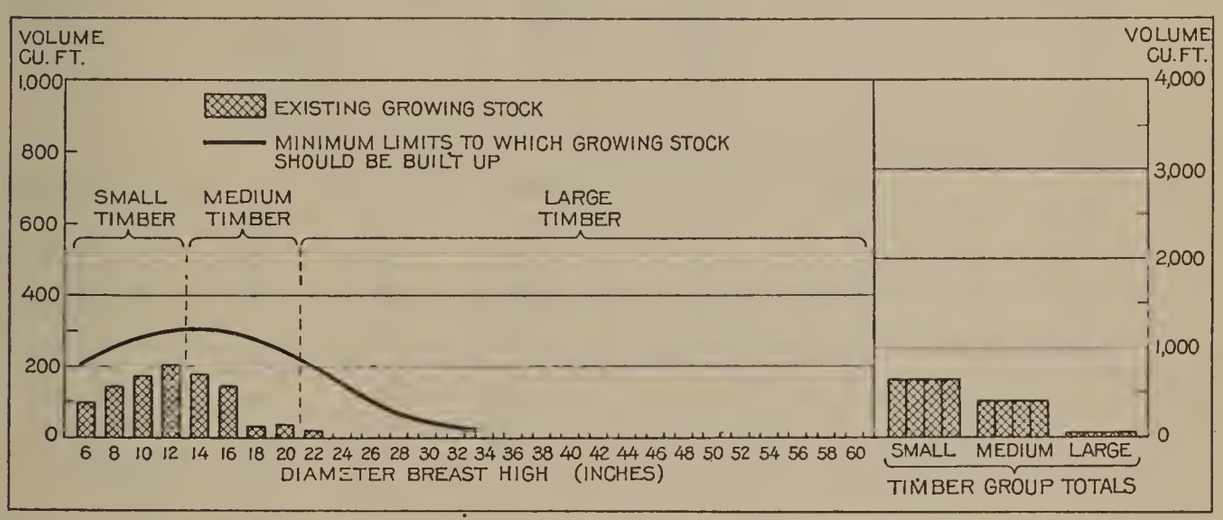

FIGURE 20.—Distribution of cubic volume by diameter classes on average acre, southern New England hardwoods, light stand.

been made during that period and have considerably improved the stands. There still appears to be a need of building up the growing stock, especially in the higher-diameter classes. Small trees that are not producing current growth of as high value as larger trees would produce tend to occupy too great a part of the area.

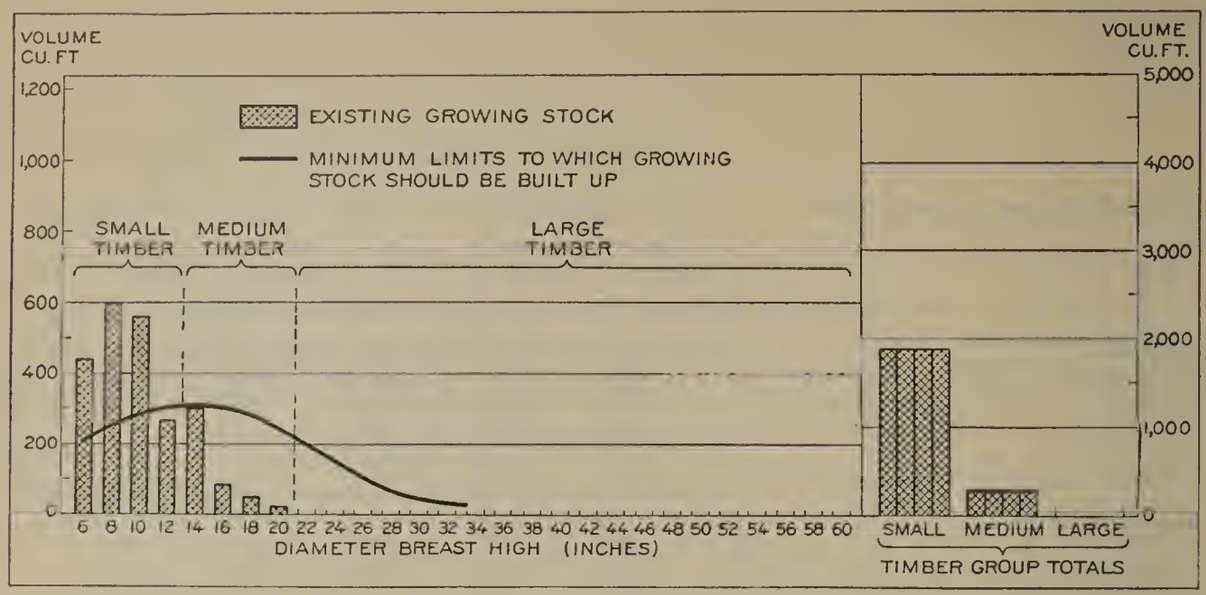

FIGURE 21.—Distribution of cubic volume by diameter classes on average acre, southern New England hardwoods, heavy stand.

TABLE 25.—*Number of trees, volume, and growth in well stocked many-aged stand oak with other hardwoods on Mont Alto State Forest, Pa.*

Tree diameters at breast height	Trees per average acre				Time required to grow to next diameter class—oak, tupelo, white ash and other hardwoods	Cubic volume	
	Oak	Tupelo and white ash	Other hardwoods	Total stand		Oak	Tupelo and white ash
Young stock:	*Number*	*Number*	*Number*	*Number*	*Years*	*Cubic feet*	*Cubic feet*
1 inch		2	118	120			0.4
2 inches	4	8	132	144	17	1.7	2.0
3 inches			36	36	10		
4 inches	2		20	22	10	3.4	
Total	6	10	306	322		5.1	2.4
Small timber:							
5 inches	2		14	16	14	4.8	
6 inches	2		8	10	14	6.6	
7 inches			6	6	6		
8 inches	4	2	6	12	18	34.6	16.2
9 inches	2	4	4	10	12	28.4	26.0
10 inches	2		2	4	20	37.2	
11 inches	4			4	17	78.8	
12 inches	4	2	4	10	16	98.6	47.4
Total	20	8	44	72		289.0	89.6
Medium timber:							
13 inches		2	6	8	9		40.4
14 inches		2	2	4	11		62.0
15 inches		2	2	4	5		68.0
16 inches	4	2	4	10	7	183.6	84.0
17 inches	4	2	2	8	9	207.0	96.8
18 inches	2			2	6	119.8	
19 inches	6			6	6	404.2	
20 inches	2			2	18	145.0	
Total	18	10	16	44		1,059.6	351.2
Large timber:							
21 inches	8			8	7	699.4	
24 inches	2	2		4	6	211.0	194.2
25 inches	2			2	10	217.4	
26 inches	2			2	7	217.4	
27 inches		2		2	6		219.4
28 inches	2			2	5	222.6	
Total	16	4		20		1,567.8	413.6
Total for average acre	60	32	366	458		2,921.5	856.8

TABLE 25.—*Number of trees, volume, and growth in well stocked many-aged stand oak with other hardwoods on Mont Alto State Forest, Pa.*—Continued

Tree diameters at breast height	Cubic volume—Continued		Saw-timber volume				Average annual growth of saw timber—oak, tupelo, white ash and other hardwoods
	Other hardwoods	Total	Oak	Tupelo and white ash	Other hardwoods	Total	
Young stock:	*Cubic feet*	*Cubic feet*	*Board feet*	*Board feet*	*Board feet*	*Board feet*	*Board feet*
1 inch	9.6	10.0					
2 inches	30.0	33.7					
3 inches	27.0	27.0					
4 inches	28.0	31.4					
Total	94.6	102.1					
Small timber:							
5 inches	33.0	37.8					
6 inches	32.8	39.4					
7 inches	30.6	30.6					
8 inches	61.6	112.4	84	40	140	264	2.9
9 inches	49.8	104.2	76	130	170	376	4.2
10 inches	31.0	68.2	110		110	220	2.4
11 inches		78.8	268			268	3.0
12 inches	93.0	239.0	352	200	380	932	10.4
Total	331.8	710.4	890	370	800	2,060	22.9
Medium timber:							
13 inches	150.0	190.4		190	640	830	9.2
14 inches	70.8	132.8		270	330	600	6.7
15 inches	70.0	138.0		350	290	640	7.1
16 inches	173.2	440.8	880	400	780	2,060	22.9
17 inches	83.8	387.6	1,120	460	330	1,910	21.2
18 inches		119.8	620			620	6.9
19 inches		404.2	2,360			2,360	26.2
20 inches		145.0	870			870	9.7
Total	547.8	1,958.6	5,850	1,670	2,370	9,890	109.9
Large timber							
21 inches		699.4	4,780			4,780	53.1
24 inches		405.2	1,260	1,100		2,360	26.2
25 inches		217.4	1,500			1,500	16.7
26 inches		217.4	1,490			1,490	16.5
27 inches		219.4		1,560		1,560	17.3
28 inches		222.6	1,600			1,600	17.7
Total		1,981.4	10,630	2,660		13,290	147.5
Total for average acre	974.2	4,752.5	17,370	4,700	3,170	25,240	280.3

OAK-CHESTNUT TYPE ON THE MONT ALTO STATE FOREST, PA. (*33*)

In the stand represented by figure 22 and table 25 chestnut has been killed out by the chestnut blight and has been almost completely replaced by other hardwood species. The stand has had excellent care for a quarter century or more, with cuttings which removed inferior trees and species. In this way its growing stock has been built up far beyond what will ordinarily be found within privately owned forests. During this building-up process large volumes of timber have been harvested and efficient fire protection has been provided at all times. Only through such procedure can private owners obtain profitable returns from their holdings. The growing stock limits suggested are averages applying to an entire compartment where cuttings are made periodically.

WHITE PINE-HEMLOCK TYPE IN PENNSYLVANIA (*32*)

The stand represented by figure 23 and table 26 is an example of a very small remnant of forests which formerly occupied large areas

in Pennsylvania. Not enough of such forests is left to be of any immediate importance from the standpoint of management. The

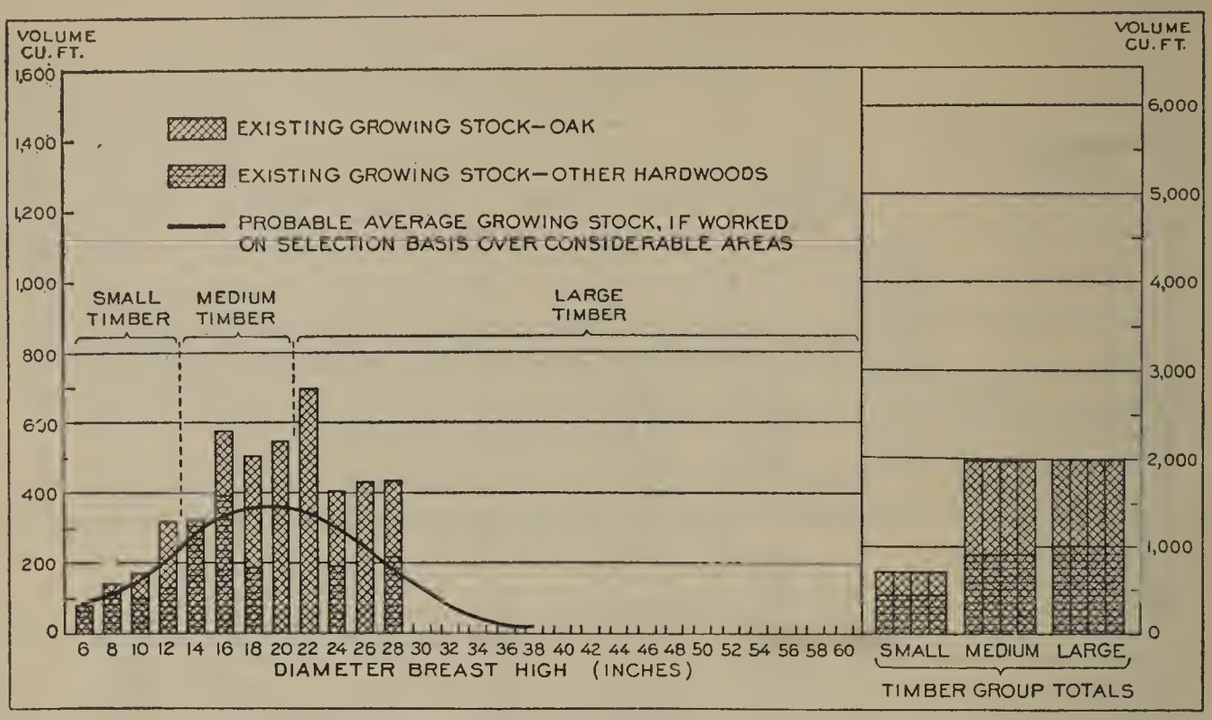

FIGURE 22.—Distribution of cubic volume by diameter classes on average acre, well-stocked oak-hardwood forest, from ½-acre plot, Mont Alto State Forest, Pa. Very few stands in the region outside the State forest have such excellent stocking.

stand is of interest, however, as showing that the virgin forests of the region formerly contained a very heavy growing stock. Good man-

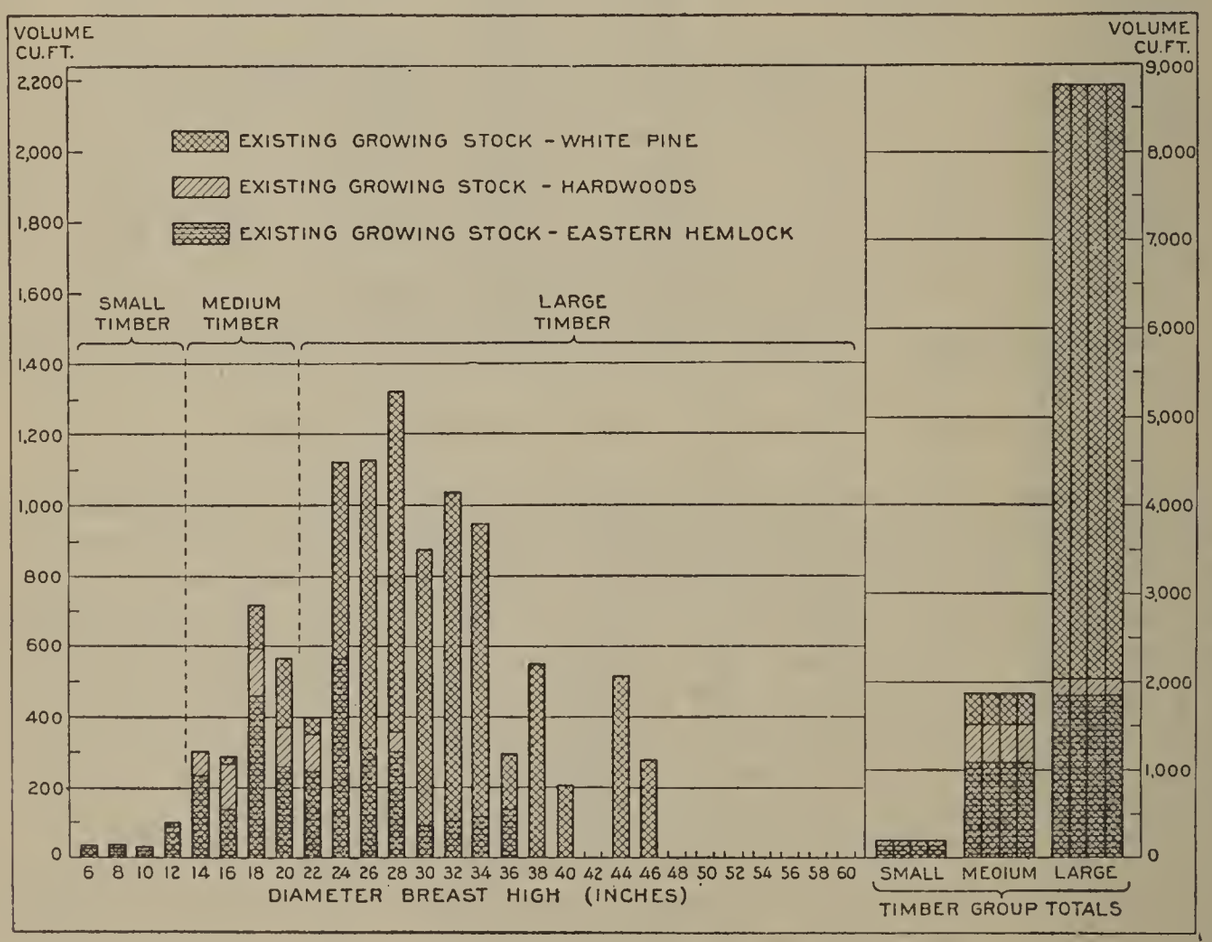

FIGURE 23.—Distribution of cubic volume by diameter classes on average acre, virgin white pine, Pennsylvania.

agement necessitates building up stands toward that condition, but, of course, not to the full degree shown by the virgin forests.

TABLE 26.—*Number of trees and volume in virgin stand of white pine, hemlock, and hardwoods, Pennsylvania*

Tree diameters at breast height	Trees per average acre				Cubic volume				Saw-timber volume			
	White pine	Hemlock	Hardwoods	Total stand	White pine	Hemlock	Hardwoods	Total	White pine	Hemlock	Hardwoods	Total
Young stock:	*Number*	*Number*	*Number*	*Number*	*Cubic feet*	*Cubic feet*	*Cubic feet*	*Cubic feet*	*Board feet*	*Board feet*	*Board feet*	*Board feet*
2 inches		144.0	296.8	440.8		28.8	89.0	117.8				
4 inches		11.2	12.0	23.2		11.2	8.4	19.6				
Total		155.2	308.8	464.0		40.0	97.4	137.4				
Small timber:												
6 inches		8.8	2.8	11.6		26.4	7.3	33.7			70	70
8 inches		4.0	.4	4.4		32.0	3.1	35.1		100	16	116
10 inches		1.6	.4	2.0		24.0	6.2	30.2		64	21	85
12 inches	0.4	3.2	.4	4.0	13.2	76.8	8.6	98.6	48	160	28	236
Total	.4	17.6	4.0	22.0	13.2	159.2	25.2	197.6	48	324	135	507
Medium timber:												
14 inches		6.8	2.4	9.2		238.0	67.4	305.4		544	223	767
16 inches	.4	2.8	2.8	6.0	24.0	137.2	127.7	288.9	104	336	448	888
18 inches	1.6	7.2	2.4	11.2	123.2	460.8	139.2	723.2	560	1,368	504	2,432
20 inches	2.0	3.2	1.6	6.8	196.0	262.4	114.4	572.8	920	832	448	2,200
Total	4.0	20.0	9.2	33.2	343.2	1,098.4	448.7	1,890.3	1,584	3,080	1,623	6,287
Large timber:												
22 inches	.4	2.4	1.2	4.0	48.0	247.2	107.8	403.0	238	864	432	1,534
24 inches	4.0	4.4		8.4	568.0	563.2		1,131.2	3,775	2,200		5,975
26 inches	4.8	2.0		6.8	816.0	312.0		1,128.0	4,488	1,240		5,728
28 inches	4.8	1.6	.4	6.8	979.2	300.8	58.0	1,338.0	5,496	1,200	272	6,968
30 inches	3.2	.4		3.6	784.0	89.2		873.2	4,416	380		4,796
32 inches	3.2	.4		3.6	934.4	104.0		1,038.4	5,248	456		5,704
34 inches	2.4	.4		2.8	829.8	118.4		948.2	4,632	544		5,176
36 inches	.4	.4		.8	160.8	134.4		295.2	898	680		1,578
38 inches	1.2			1.2	552.0			552.0	3,096			3,096
40 inches	.4			.4	208.8			208.8	1,172			1,172
42 inches												
44 inches	.8			.8	520.0			520.0	2,896			2,896
46 inches	.4			.4	284.8			284.8	1,564			1,564
Total	26.0	12.0	1.6	39.6	6,685.8	1,869.2	165.8	8,720.8	37,919	7,564	704	46,187
Total for average acre	30.4	204.8	323.6	558.8	7,042.2	3,166.8	737.1	10,946.1	39,551	10,968	2,462	52,981

FURTHER MEASURES NECESSARY TO IMPROVE FORESTRY PRACTICE

While it is probable that considerable additional forest areas will be taken into public ownership in these regions, all observers agree that great areas of forest land will remain in private ownership. The relation of forest taxation to the problems of private forestry is handled elsewhere in this report. Public fire protection is generally effective and only needs strengthening in certain localities. These foundations for private forestry having been laid, the time has arrived when it is possible to press forward to other necessary measures of improvement.

Of the remaining measures needed to improve the quality and increase the volume of forest production throughout the two regions, the most important is to revise cutting methods, with greater attention to saving the right kind of growing stock. This would mean as complete displacement of defective and inferior growing stock as could gradually be brought about. The demand for fuelwood should be met by this material together with otherwise unmerchantable parts of saw-timber trees. There is also need of the development of manufacturing practices through which inferior trees that should be thinned from the stands could be utilized for many of the products commonly used locally. It has already been mentioned that the older manufacturing plants are more or less handicapped owing for one thing to lack of local supplies of raw material of the quality they were designed to use. There is good reason to believe that methods can be developed which will obviate this handicap.

In order to accomplish this, close cooperation between forest owners, manufacturers, and technicians is needed. Any improvement in manufacturing practice which permits the use of small-sized material will damage rather than improve the forest conditions unless the cuttings are rigidly held to the kind of material that should be removed from the stands. The realization of some returns by labor or even some small return from stumpage in premature cuttings can never take the place of the far greater return to all participants in the industry when a reasonable proportion of the stand is left to reach full development before cutting. Once the growing stock is built up it will be a fairly simple matter to maintain it by silvicultural methods.

The coordinating influence of public agencies will be needed to bring to bear the vast fund of existing technical information applicable to such projects.

The first attempts at such improvements in manufacturing practice should be centered in communities where the cooperative spirit exists between forest owners and manufacturers and where the manufacturing enterprises are well adapted or can be adapted to utilization of the forest raw material that is available. Further investigation should be carried on in these places at the same time the existing knowledge is put into use.

The woodworking plants in the regions are widely diversified as to the products they manufacture; in this aspect the situation is excellent. Since many of these plants are old, it is evident that some new plants will be needed as time goes on. These should be located very carefully with respect to transportation of raw materials to the plants and finished goods to market. Earnest attention should be given to

modern design in accord with the best principles of production engineering and to adaptation of technical processes. Finally, the folly of locating in a single community plants in excess of the productive capacity should be scrupulously avoided. Efforts to rebuild the forest capital cannot be expected to succeed if the wastage that accompanied early exploitation of the forest is allowed to continue.

MEASURES NECESSARY TO SPEED UP ADOPTION OF IMPROVED FOREST-MANAGEMENT PRACTICES

In handling the relatively small areas of well-stocked forest that now remain, together with such areas as have partially restocked and have promise for the future, the time element is of great importance. Neither the forest owners, the forest regions, nor the Nation can afford to allow the forest productivity to go into further decline. In many localities a relatively few years' prolongation of a liquidation policy would set back for a generation the opportuuity for private forestry to yield any immediate profit. In order to present a well-rounded picture of the measures involved in placing private forestry on a firm foundation, it is necessary to touch briefly on certain matters which have been discussed more fully earlier in this section, and also to touch on certain items which have not been treated in this section but have been treated fully elsewhere in this report.

CONSOLIDATING AND STABILIZING FOREST-LAND OWNERSHIP

As was noted earlier in this discussion, operating economy can be very materially advanced, both as to utilization of the present stand and as to permanent sustained-yield operation, by carefully assembling areas into natural economic units. The savings from proper size, shape, topographical form, and timber-transport facilities are, of course, most apparent in regions of rough topography such as is common in the West. Even on flat areas, location with regard to rivers, highways, railroads, manufacturing centers, and local markets is of great importance.

In order to take advantage of these savings all classes of owners in a given territory may well join in breaking the area into effective operating units. Each unit can then be transferred to a single ownership or the various owners can cooperate formally or informally in locating manufacturing plants and transportation routes, allocating the annual cut among various properties, etc. In working out these transfers and plans the aim should be to promote stability of ownership.

If the private owner is not interested in permanent ownership and care of this area, it is in his interest to maintain it in the best condition possible until it can be transferred to some stable form of ownership. Irresponsible ownership of forest areas is no longer justifiable.

ORGANIZING AND ADMINISTERING THE FOREST BUSINESS

Poor planning is as costly in forest business operations as in other lines of business. One of the first steps to be taken by the forest owner who has sensed the continuous-production possibilities of his holdings is systematic organization of the business. This means carefully eliminating many losing practices such as cutting stands and

trees prematurely and constructing unnecessary improvements of only temporary value. It will provide for going over the property in an orderly manner within 5 or 10 years to harvest timber that is financially mature and salvaging where possible fungus-infected, insect-killed, windfall, and fire-scarred timber. It will also provide for a systematic gradual development of permanent transportation facilities and other forest improvements and for fire protection. Even on the property with impaired growing stock this systematic procedure accompanied by limitation of the cut will gradually rebuild the growing stock and productivity of the area. The systematic operation and the permanent improvements will also widen the margin of profit on stumpage cut. Above all it is necessary to remember that, as shown in the discussion of management of shortleaf loblolly pine stands in the South, well-stocked stands produce from two to three times as much per acre as poorly stocked stands, although taxes and the costs of fire protection and administration usually amount to no more per acre in the well-stocked stands. The cost of producing stumpage is, therefore, two to three times as great in poorly stocked forests.

ELIMINATING FROM COMMERCIAL FOREST AREAS PUBLIC SERVICES UNNECESSARY TO FOREST USE

Scattered settlement throughout forest areas creates, according to American standards, the need for schools, roads, and other services scattered through the areas. Such services cannot be supplied economically under these conditions and the result may be tax rates which, in themselves, tend to make forest use unprofitable. Normally, all but a small percentage of the labor required by forest industries is concentrated at manufacturing plants or elsewhere rather than scattered through the forest area. It is only in this manner that permanent living accommodations of the better class can be provided. This concentration is to the advantage of both employer and employee. Such communities can be supplied with public services economically and without imposition of an undue tax.

RESEARCH AND DEMONSTRATION

The general subject of forest research is discussed in another section of this report. Since forest ownership and also the manufacture of forest products is mostly in small units, forest research for the most part is carried on by public agencies. Such research has had very marked results in the past few years, but existing facilities for bringing these results to bear on the management of private forests have not proved altogether adequate. To meet this situation there is need to single out in each region a number of enterprises and a number of communities in which research workers, forest owners, and forest industries can cooperatively demonstrate the application of existing knowledge to some of the many problems remaining to be solved. These include:

1. Forest-growing problems, particularly that of removing the proper trees from the stand to obtain current income and at the same time prepare the stand to increase more rapidly both in volume and in volume.

2. Wood-utilization problems, particularly that of developing methods of getting out the numerous classes of forest raw materials most economically and without damage to the remaining stand. Closely connected with this problem is that of preparing and grading forest raw materials in a manner to adapt them as closely as possible to the requirements of manufacturers. At the present time large losses occur because various products are manufactured from logs of wholly unsuitable size and quality.

3. Manufacturing problems: The largest such problem, one which must rapidly grow more accure, is that of utilizing logs or bolts from inferior trees or species. Closely related to this is the division of manufacturing processes among different plants. At the present time large quantities of lumber having numerous defects are shipped to furniture manufacturers and other users of small clear pieces of wood. Since this involves waste of from 30 to 50 percent of the volume, important savings in transportation and often in manufacture can be effected by performing the initial manufacturing operations nearer the source of the timber. This procedure may result also in saving much timber too low in grade to be manufactured into lumber.

4. Marketing problems: Much remains to be done in this field, including educating the public to put each species to its proper use. Because liberal supplies of "all-purpose" woods have been available until within rather recent years, the growing need to discriminate in using lumber and other forests products of different species has been little realized.

5. The problem of correlating and coordinating all activities that touch the forest: This is the only means of stopping the present widespread waste both of forest products and of forest productivity and of preserving and building up forest productivity. It is entirely reasonable to expect that if this problem is solved in numerous communities and enterprises scattered throughout the forest regions, the example will be followed by other communities and enterprises. It is here proposed that investigation, demonstration, and extension be carried on jointly in selected communities and that increase of knowledge and practical application be pushed forward together.

SEPARATION OF FOREST HOLDINGS FROM MANUFACTURING

There are no doubt numerous cases of pulp and paper and other wood-manufacturing enterprises of such assured permanence that the owners are justified in engaging in forest management operations in order to provide themselves with a permanent supply of raw material. The assumption that this is universally necessary or desirable is of much the same order as assuming that a meat-packing plant should engage in the stock business. As a matter of fact the business of continuous forest management and the business of manufacturing and selling forest products are very distinct fields requiring wholly different abilities. The great need of a forest business is an outlet for many sorts and sizes of forest material. No one type of manufacturing plant can use all these sorts of material. Therefore to provide every forest property or even the very large properties with complete outlets would multiply plant investments beyond all possibility of their yielding satisfactory earnings. Economical use of capital as well as adequate attention to management details generally limits

the forest owner to following his products through the preparation of raw material properly graded for the use of the manufacturers. Under these conditions the forest owner having no absolute demand for a certain annual cut can keep his cuttings to a minimum during periods of low prices and cut more heavily when demand is heavy. Close attention to movement of stumpage prices on each tree size and portion of the stand is one of the chief elements in obtaining the maximum return from a forest property.

PERFECTING STATISTICAL INFORMATION, ETC.

It is generally recognized by economists and business authorities that reliable current information on production, sales orders, inventory, etc., in his industry is an absolute necessity to the modern business manager. The Bureau of the Census and the Forest Service have for many years collected national statistics at 1-year, 5-year, or 10-year intervals. It is hardly to be expected that such statistics can be collected at Government expense more frequently than once a year. For this reason several trade associations collect weekly statistics in their territory. These are not always complete in any given territory, and some territory is not covered. It is essential that the system of collection be perfected and that a liason be arranged between Government and trade-association work in order that complete statistics may be available on a weekly basis, for the country as a whole. By the cooperative application of modern statistical methods relying on properly selected samples this work could be perfected at little increase in expense. This is in the interest of owners, managers, employees, consumers, and all other persons having to do with forest industry or forest products.

OTHER TRADE-ASSOCIATION ACTIVITIES

Forest industries are as a general rule well organized into trade associations. It appears that any steps toward better production control or a better planned and less wasteful operation of the industry must make important use of these associations. The frequent collection of statistics has already been mentioned as one important function of the trade association. Standardization, inspection of products, and sales promotion have long been recognized as important trade-association fields of activity. The associations have also encouraged better business ethics. Additional activities such as regional sales or organization and establishment of production quotas have not been studied sufficiently to warrant any conclusions. Some of these cannot be engaged in without modification of existing laws. It is in accord with American tradition that any such practices should be on the basis of voluntary cooperation.

ORGANIZATION OF FOREST CREDIT FACILITIES

The organization of forest credit facilities is discussed in another section of this report. It is believed that such organization properly worked out under the supervision of the Federal Government can be of considerable assistance in stabilizing the underlying finance of forest ownership and relieving pressure for liquidation. The ultimate aim of such organization should be to bring about a flow of credit capital

sufficient, in conjunction with owners' capital, to enable forest owners, forest workers, and forest-products consumers to take full advantage of the great industrial opportunity offered by our forest resources.

REVISION OF FOREST TAXATION

Revised methods of forest taxation are discussed in detail in a report now being prepared by the Forest Taxation Inquiry.

FINAL MEANS TO INSURE CONTINUED PRODUCTIVITY

The measures mentioned in the foregoing virtually exhaust the means by which private forestry can be encouraged and facilitated. Failure of these measures would necessitate resort to more drastic measures. One of these is governmental regulation of the management of forest property. The methods utilized in such governmental regulation in various countries and the limited measures so far adopted in this country are discussed elsewhere in this report. The other and final measure is public ownership and management of the resource to the end that a continuous supply of raw material may be available to the forest industries. It is probable that stability will eventually be obtained by a judicious distribution of private and public management according to the economic and physical conditions present in each locality.

SUMMARY

1. Owing to the almost complete removal of the forest capital from about 40 percent of the privately owned forest land and to very material reduction on an additional 30 percent, less than 280 million acres out of the 396 million acres of privately owned forest land in the United States is capable of being organized into sustained-yield forest properties from which annual returns can be expected immediately.

2. Of this area 127 million acres is in farm woodlands and is managed as part of the farm business. Improved practices are needed on this acreage.

3. Of the remainder about 2,300,000 acres has actually been organized for sustained yield and an additional 15,600,000 acres is being subjected to various measures designed to prolong productivity in some measure. Beyond this, large areas are being partially protected from fire.

4. The liquidation policy applied to private forest lands has resulted in a costly waste of industrial assets. Wherever practicable, this policy should be abandoned in favor of a sustained-yield policy, to save the heavy costs of depletion and other losses.

5. The selection system with short cutting cycles provides in most forests an effective means of preserving and building up growing stock. At the same time in most cases it increases current returns from forest properties.

5. The extent to which forest properties have been liquidated, and the consequent critical state of the growing stock in most regions, call for prompt action placing suitable forest properties under responsible organized permanent management.

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